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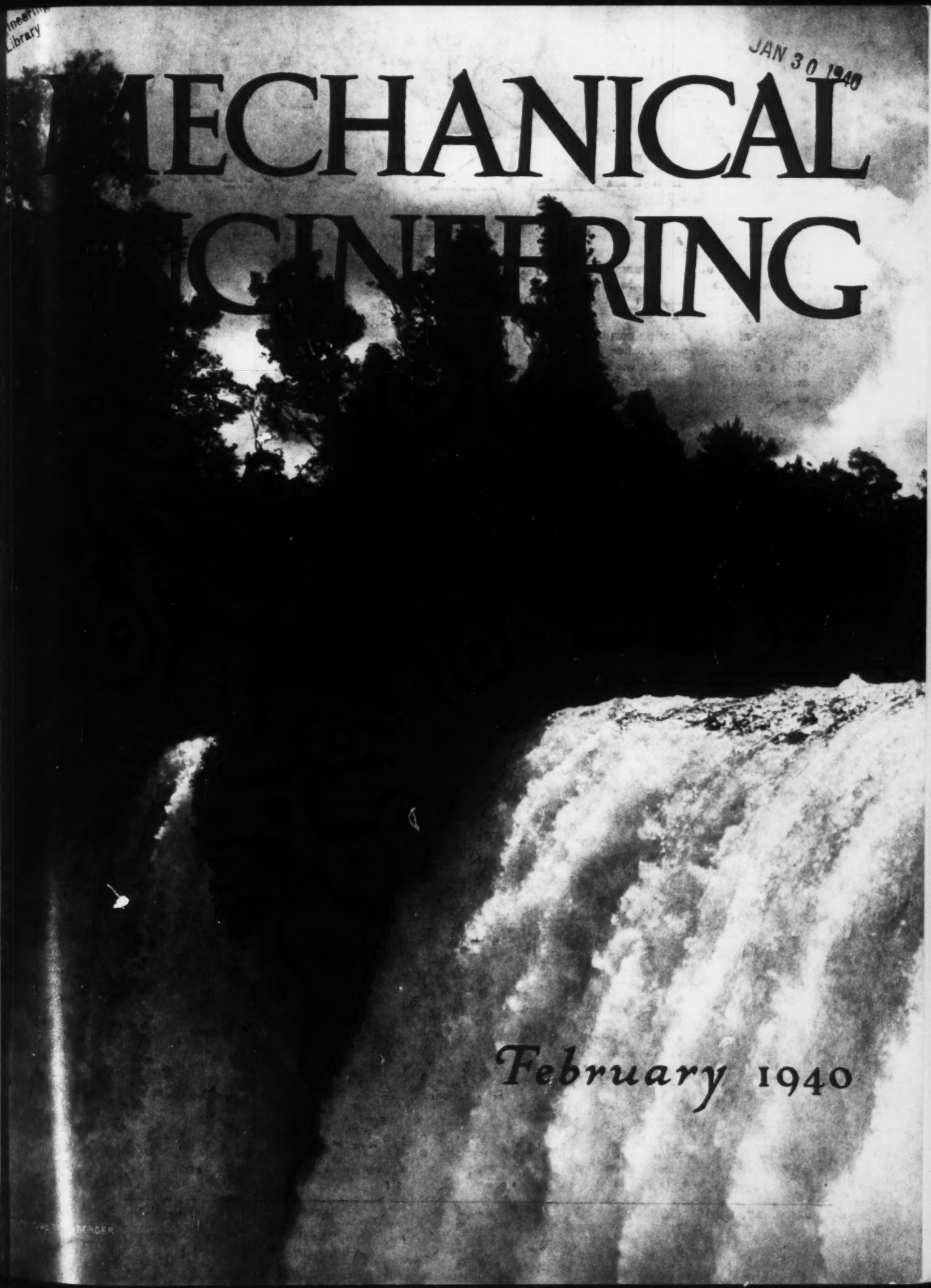

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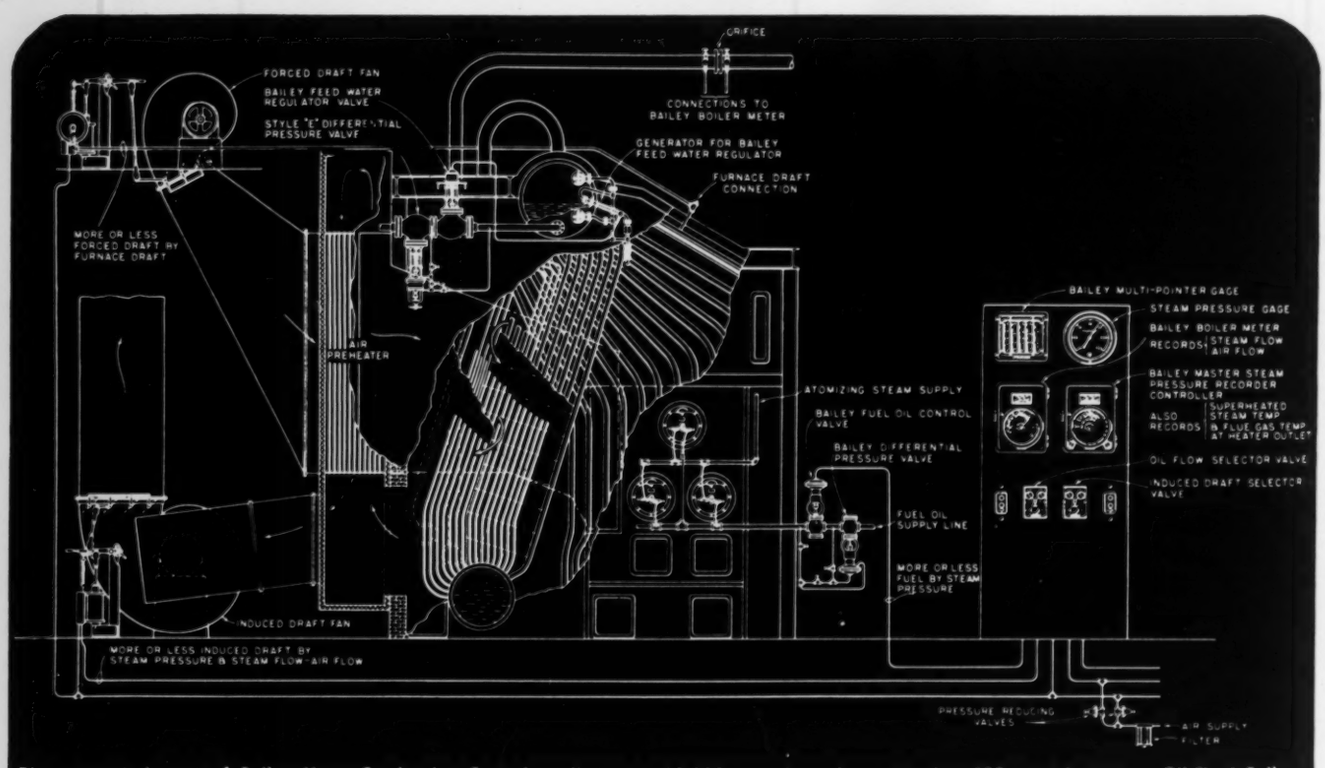
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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 62 NUMBER 2

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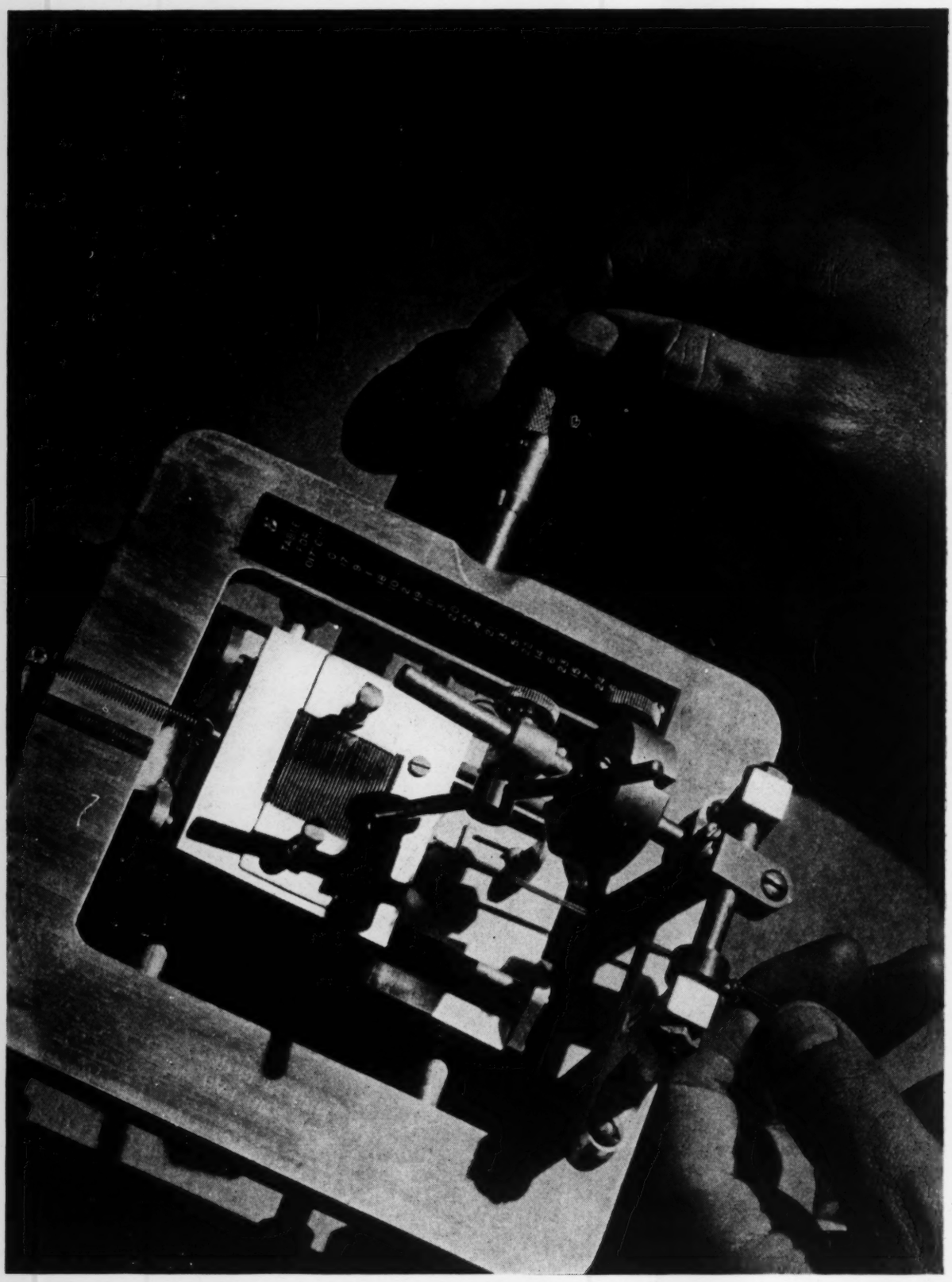

"Precision"

(Photograph taken by S. E. Surdam and shown at the Fourth Annual Photographic Exhibit held during the 1939 A.S.M.E. Annual Meeting in Philadelphia.)

VOLUME 62
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MECHANICAL ENGINEERING

FEBRUARY
1940

GEORGE A. STETSON, *Editor*

The Cover

OUR cover picture gives rise to many thoughts. The original photograph was part of an unusually fine exhibit conducted by C. E. Bonine and his committee in connection with the 1939 Annual Meeting of the A.S.M.E. held in Philadelphia in December. It is a reminder of the face of Nature, before the hand of man has touched it, where force and power are delineated in beauty. Here upon the almost eternal rocks Nature maintains the slow cycle of growth and decay and biologic change and the swift movement of water that never returns yet looks always the same. Here the energy of the sun, caught momentarily in leaf and raindrop, slips tirelessly and unseen into other forms. Here life inevitably feeds on life in the unwatched equilibrium of Nature's economy.

The picture too is a reminder of the great continent of which it shows a single scene. Were it not for the testimony of the photographer it might have been snapped in almost any part of the world, so common are the elements of which it is composed and so profligate is the hand of Nature that blended them. It is therefore symbolic of the common heritage of man that should draw all men together. It is a reminder that men themselves have a common origin, that they have common wants, and that they are motivated by common emotions even though they live in widely separated regions of the world.

Of especial significance, however, is the reminder that the peoples of the two great continents of North and South America have today a particularly urgent need for one another. Separated by distance, by differences of race, language, and tradition, these peoples are more likely to emphasize the differences than the similarities. The situation merits close attention and arouses the hope that the exchange of engineering thought and service may result in closer relations and a broadening of mutual respect and understanding.

One of the great causes which the late Calvin W. Rice advanced was a better understanding of the peoples of these two continents. In his name and in the spirit of his international thinking a lectureship was established by the A.S.M.E. under which engineers of other countries are invited to address our own members. Last year this Rice lecturer was Rodolfo E. Ballester, of the Argentine, whose trip to this country forwarded the cause so dear to Mr. Rice. Dr. Ballester's address, published in our August, 1939, issue, has been translated and has appeared in several South American journals. It added another link in the ties that should bind the engineers of the two continents. More links are needed. Our cover picture is not only a reminder of the common resources and beauty of all continents, but also of the opportunity that exists for developing the resources of good will, friendship, and common interests of the men that inhabit them.

An Early Inventor

TO THE present generation of engineers, machines and the applications of science to useful ends are so commonplace that it comes as a distinct shock to discover for the first time, as everyone must, the crude and inefficient devices that were the ingenious marvels of invention in the days preceding the industrial revolution. To our superior knowledge of science and mechanics we must also add the availability of innumerable materials of construction unknown not so many years ago and of machine tools wherewith metals can be formed and worked with a precision that would have seemed inconceivable to our ancestors, if we are to account for our rapid progress.

The study of early examples of mechanical invention cannot fail to impress the student of our time with the extreme youth of the engineer's art and with the handicaps under which the pioneers in it worked. There is, moreover, to be gained from such study the chastening sense of humility that comes with recognition of the heavy debt we owe to the past and with the realization of how small our own contributions are, wonderful as they may seem to us, when the richness of two hundred years of activity in this field, upon which we all draw, is compared with the meager store of knowledge and experience that guided the work of our predecessors in engineering progress.

It is salutary, therefore, to read such a pamphlet as that recently issued by the Swedenborg Scientific Association of Philadelphia, "The Mechanical Inventions of Emanuel Swedenborg," translated and edited by Alfred Acton. Readers may recall that in our issue of March, 1938, attention was directed to the two hundred and fiftieth anniversary of this great Swedish engineer and mystic. The pamphlet now referred to contains descriptions and sketches of some of Swedenborg's contrivances and suggested mechanisms that cover a wide range of interest and speculation. Although these include flying machines, the machine gun, and underwater craft, Dr. Acton disclaims the intention of viewing them as "anticipations of the marvelous machines that now enrich the world," but says, rather, that they "were applications of well-known mechanical principles—

applications which bear ample enough testimony of the genius of the inventor."

Among the many devices described was one "probably thought out by Emanuel during the spring or autumn of 1717, when he was engaged in superintending the construction and sinking of the great dam at Carlscrona which was necessary before the blasting of the rocks for the construction of the admiralty's dry dock could be commenced." This was the model towing tank, or as quaintly put, "a method of ascertaining the powers and qualities of ships of different kinds and construction." The use to which models are now put and the rich technique that has been developed by which results of model tests in various fields are interpreted for the designer's use, are evidence of the primary importance of the scheme envisioned by this extraordinary pioneer. The pamphlet will repay a careful reading and make an inexpensive accession to the library of an engineer interested in the history of his profession.

Committee Dinners

SEVERAL A.S.M.E. committees follow the practice of holding annual dinners at which past and present members come together to honor a retiring chairman, to greet former associates, to introduce new incumbents to the spirit and tradition of the group, and to discuss in an informal manner matters of policy that go forward more smoothly when men "see truth dawn over the glass's brim." This season, when personnel changes, provides the occasion for most of these dinners. They have become such an important factor in Society life that it is appropriate to direct attention to them.

As reported in the *A.S.M.E. News* for this month the Committee on Local Sections held its twenty-fifth reunion and the Railroad Division's executive committee its annual dinner in connection with the 1939 Annual Meeting. These gatherings were followed on January 5 by the dinner of the Committee on Meetings and Program, on January 10 by that of the Committee on Professional Divisions, and on January 26 by the annual reunion of the Committee on Publications. Elliott H. Whitlock, C. T. Ripley, R. F. Gagg, L. K. Sillcox, and George F. Bateman were the members honored at these dinners.

It would add immeasurably to the morale and loyalty of Society members if they could be unseen witnesses at these intimate and informal dinners; and it is unfortunate that opportunity does not exist for every Society member to serve on one of its committees. Although the proportion of members so engaged is relatively high in keeping with Society policy, practical considerations set limitations to the number of members who can and will serve. Those who do, however, find such rich reward in satisfactions of a variety of types that the sacrifices of time, money, and effort become inconsequential.

What strikes the observer at these dinners as being their most remarkable characteristic is the intensely genuine spirit of loyalty committeemen have for the Society and for the personal friends that have resulted from common service. On many committee reunion lists are honorary members and past-presidents of the Society and men of high reputation and important influence in engineering and industrial affairs. There are also youngsters, the junior advisory members, just commencing their Society and professional careers. A common cause and common service have united them all. Lifelong friendships have enriched the experiences of administrative tasks for the benefit of fellow engineers. Here are to be seen those intangible benefits that men create for themselves. Here is demonstrated the oft-repeated truth that you get out of an organization in proportion to what you put into it. Here the impersonal business of conducting Society affairs for the benefit of members and the public acquire human values and spiritual significance.

Science Advances

THIS is not the first issue of this magazine in which the name of Enrico Fermi has appeared, although never before has it been signed to an article, nor is it the first in which the fascinating subject of nuclear chemistry has been mentioned. It is to be hoped that the distinguished Nobel prize winner will find occasions in the future to address engineers through these pages, and certainly the rapid advances that are being made in the field of which he writes will afford an increasing amount of interest for engineers as researches in it bring the subject matter closer to the practical work in which they must engage.

What the researches about which Dr. Fermi writes will ultimately mean to engineers and to the world in general, the scientists engaged in making them are too cautious to predict. We do know, however, that they have demonstrated the possibility of transforming matter into energy and of changing one material into another. These are not startlingly new achievements. What is startling about the recent discoveries, if a layman understands them, is that a self-generating chain reaction has been found from which one might hope to expect the release of energy in amounts greater than those necessary to break the nucleus apart, and that the new substance is radically different from that from which it came—a substance of about half the original atomic number instead of one differing by only a few digits.

Hence one ventures to predict that the cyclotron, that ingenious device by means of which an abundant stream of particles at extremely high voltages can be made available, will become one of the most significant tools of science, and that the discoveries it makes possible may profoundly affect engineering practice. Following the pattern of other discoveries of science, those which undoubtedly will flow from this new attack on nuclear physics can only be guessed at—perhaps the most useful of them are as yet unsuspected. The patient work of hundreds of scientists and later the skill and ingenuity of engineers will find the ways of using them for the benefit of mankind.

NUCLEAR DISINTEGRATIONS

By ENRICO FERMI

COLUMBIA UNIVERSITY, NEW YORK, N. Y.

A LARGE part of the information that is available at present on the structure of atomic nuclei has been gathered by a successful application of the technique of the so-called nuclear bombardments. This technique, that was initiated about 20 years ago by Lord Rutherford, consists in hurling against the nucleus a projectile (in the first cases this was one of the alpha particles spontaneously emitted by radioactive substances) and in observing the changes in the nuclear structure produced by the impact. In the last years this technique has received new impetus due, on one hand, to the development of artificial sources of high-energy projectiles (high-voltage apparatus and cyclotrons), and on the other hand to the discovery of the neutron.

The cases of artificial nuclear disintegrations that have been investigated at present are several hundreds. Their study has led to the development of a nuclear chemistry in which, instead of changes of aggregations of atoms to form different molecules, as in chemistry, changes in the aggregation of neutrons and protons to form different nuclei are observed. This nuclear chemistry obeys rather simple rules, and the different types of nuclear reactions can be summarized as follows:

Nuclei have been bombarded so far mostly with the following types of projectiles: alpha particles, protons, deuterons, and neutrons. Whenever one of these particles strikes the nucleus it is incorporated into the nuclear structure, and another particle may be emitted which belongs to one of the same four types above described. In a few cases nuclear reactions have been produced by hard γ rays or by high-energy electrons. We have further to add the very many cases of radioactivity, both natural and artificial, in which an unstable nucleus spontaneously emits an α particle, or an electron (negative or positive). The residual nucleus that remains after the reaction is in all these cases different from the one before the process. In general, however, the changes in atomic weight, or atomic number, are not very large. Indeed, the greatest changes in atomic number occur when an α particle is either absorbed or emitted in the process. Since the electric charge of the alpha particle is of two units, this produces the displacement in the atomic number of two places only.

In very many cases in which a chemical identification of the reaction products of nuclear bombardment has been possible, it has been found consistently that the reaction products are either isotopes of the original element bombarded, or they differ from it in atomic number by only few units. There was, therefore, a great sensation among nuclear physicists last year when Hahn and Strassman announced that by bombardment of uranium (atomic number 92) with neutrons, they had found definite evidence of the formation of some radioactive isotopes of barium (atomic number 56). Such a change by 36 units in the atomic number had never been considered as possible before, and subsequent investigation has shown that it corresponds to a nuclear reaction of an entirely new kind, in which the uranium nucleus splits into two fragments of comparable size.

This discovery of Hahn and Strassman has opened up a very interesting new field of investigation. It is well known that all the heaviest elements of the periodic system are to some extent unstable, as is shown by their natural radioactivity. The physical reason for this instability is the electrostatic repulsion between the positively charged constituents of the nucleus. These repulsions are approximately proportional to the square of the nuclear charge and increase, therefore, very considerably with increasing atomic number. Instability sets in when the electrostatic destructive forces overcome what we may call the cohesive forces of the nucleus.

The theory of nuclear forces is not as yet developed so far as to enable us to calculate exactly at what value of atomic number instability sets in. Very probably, however, this limit is not far beyond $Z = 92$, the atomic number of uranium. The discovery of Hahn and Strassman shows, indeed, that in the case of uranium the relatively unimportant perturbation of the nuclear structure due to the capture of a neutron, is already sometimes sufficient for breaking into pieces the nucleus, giving rise to the so-called fission process.

A very pictorial image of the process has been suggested by Bohr, who compared this process with what happens when a liquid drop divides into two smaller droplets as a consequence of a very strong oscillation in which it changes from the original spherical form into a very elongated shape. In the case of uranium, however, as soon as the two fragments are separated and the cohesive forces cease to attract them, the strong repulsion, due to the fact that both fragments are positively charged, push them apart, impressing on them a relatively enormous kinetic energy. In fact, the amount of energy released in the fission process is approximately ten times greater than any amount of energy released in atomic disintegrations, it being of the order of 200 million electron volts (Mev). Although the discovery of this process is only one year old a great many investigations have been carried out in a number of laboratories all over the world, so that a general description of the main features of the phenomenon is now possible, in which, however, many important details are still missing.

The fission process can be produced by bombardment with fast neutrons having energy above 1 Mev, and by slow neutrons, having energy corresponding to thermal agitation equivalent to a small fraction of one electron volt. Neutrons of intermediate energy are rather inefficient as agents for producing fission. It has been pointed out, especially by Bohr, that this fact might possibly be interpreted on the assumption that the fast-neutron and the slow-neutron processes are due to two different isotopes of uranium. Probably the fast-neutron process is due to isotope 238, which represents more than 99 per cent of natural uranium, whereas the slow-neutron process might be attributed to a much rarer isotope of weight 235, which is known to be present in an amount somewhat less than 1 per cent and is the parent substance of the actinium radioactive family. No direct experimental information on this point, which is of considerable importance both from the theoretical and the practical side, is at present available.

Each fragment into which uranium splits in the fission process weighs approximately one half of the original nucleus. Apparently, however, the fission does not always occur in exactly the same way, and there are certain limits between which the weight of the fragments can vary. Since each fragment gives rise to several artificially radioactive nuclei, it is clear that the fission process will produce a large variety of new radio-

An address delivered at the Winter Convention of the American Institute of Electrical Engineers, New York, N. Y., Jan. 24, 1940, following the ceremony of presentation of the Edison and Hoover Medals.

active elements. An extensive chemical investigation of these radioactive elements has been carried out in several laboratories, and has already led to the identification of more than 20 such elements, and the list is probably still far from being complete.

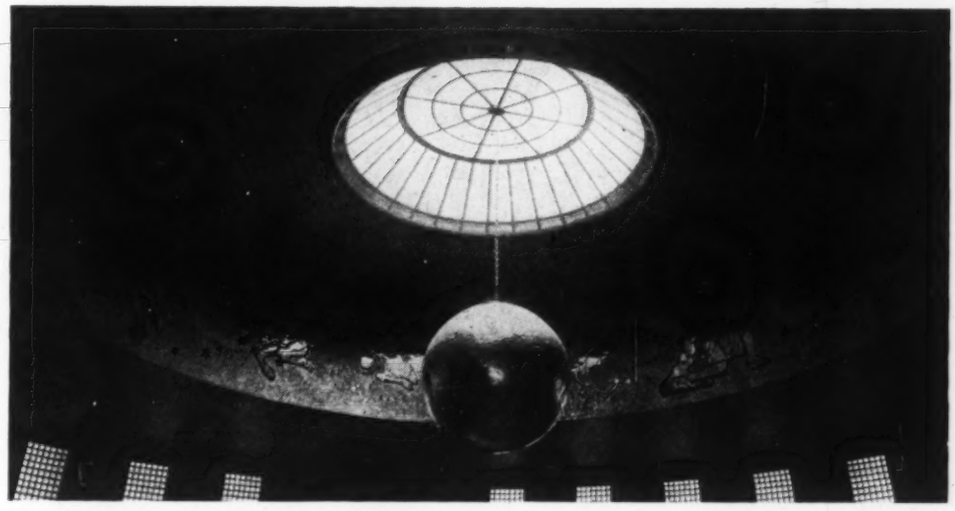
When uranium undergoes the fission some neutrons are emitted. It has not been decided so far whether these neutrons are emitted in the very act of fission, or a very short time after the process. The two fragments into which uranium splits get away with a very high internal excitation. The excitation energy might be so large as to produce the spontaneous emission of neutrons from the two fragments. The largest part of this emission of neutrons certainly occurs within an exceedingly short time after the fission; the emission of a small number of neutrons, however, lasts for some seconds after the fission process. This delayed emission of neutrons is probably a secondary process of some β disintegration.

The emission of neutrons is not only an interesting feature of the phenomenon, but might perhaps be of a far-reaching importance, as it opens at least one possibility of exploiting the fission of uranium for the production of nuclear reactions on a large scale.

Let us assume for a moment that in every fission process two neutrons are emitted (actually experiment shows that probably the average number of neutrons emitted is somewhat larger, between two and three). If this were so every neutron that enters the uranium nucleus and produces fission would give rise to two neutrons with the net gain of one. If we assume that these two neutrons again produce each one a fission we get at the end four neutrons from the original one. Any one of these four neutrons might again produce a fission, multiplying the number of neutrons once more by two, and so forth, until the number of neutrons might in principle be multiplied by an arbitrarily large factor, thus giving rise to a self-perpetuating nuclear reaction, the so-called chain reaction. In order that the chain reaction might go it is obviously necessary not only to have more than one neutron produced for every neutron that is absorbed in the process of fission, but also to be able to utilize for producing new fissions, a large faction of the neutrons produced; otherwise the loss might be larger than the gain.

Assuming, for instance, as before, that two neutrons are produced in every fission, it is evidently necessary, for the chain reaction to take place, that more than one half of the neutrons produced be used in new fission processes. There is now, on one hand, some loss of neutrons that diffuse outside of the reacting mass before they have a chance to react. This loss can be made, at least in principle, arbitrarily small, by increasing the amount of the reacting material. On the other hand, however, some of the neutrons are lost for the reaction because they are absorbed by uranium itself in a second process, that does not lead to fission but to the formation of a heavy radioactive isotope of uranium. Some absorption is finally due to those substances that must be present in order to slow down the neutrons so as to increase their aptitude to react with uranium. Whether these absorptions are or are not sufficiently large to prevent the chain reaction, cannot be answered at present. The experiments require the use of very large amounts both of uranium and of slowing-down materials and are, therefore, very expensive. The problem seems to me, however, worth the effort that its solution will cost. There is indeed a chance that research on these lines might open entirely new technical opportunities, whose range can at present be only guessed. The large release of energy by the reaction whose development, by the way, could be easily controlled by simple mechanical devices, is indeed probably only one and very likely not the most important aspect of the problem. Far more important might eventually prove the production of radioactive materials and of neutrons in practically unlimited amounts, for medical, biological, and physical investigations. In conclusion, although there is only a chance of success on these lines, the stake appears large enough to justify some gambling on the part of scientists.

Hobart, N. Y.



THE WORLD HANGS FROM THE DOME OF THE ROTUNDA OF THE ADMINISTRATION BUILDING

New York City's NEW MUNICIPAL AIRPORT

By SAMUEL E. STOTT

CHIEF ENGINEER, DESIGN SECTION, WORK PROJECTS ADMINISTRATION, NEW YORK, N. Y.

IN THE development of a modern commercial airport, before physical work is undertaken, there must be evidence apparent of sufficient traffic demand to make it economically sound and, for convenience, it must be located at a point readily accessible from a municipal center. The terrain for the site itself and its environs, within a radius of 15 miles, must be studied carefully. Furthermore the location must be suitable for navigation under all weather conditions. There can be no tall chimneys, water towers, gas tanks, or high buildings in line with approaches to the runways, since these offer serious hazards. Prevailing wind conditions must be considered when laying out the runways. Complete technical data on all these factors were thoroughly developed and studied prior to undertaking any actual construction at the New York Municipal Airport.

The nucleus of the New York Municipal Airport at North Beach, Queens, Long Island, N. Y., was a small, privately owned field which was acquired by the Curtiss-Wright Corporation in 1929 and opened a year later as the Glenn H. Curtiss Air Terminal. Years before, the site had been an amusement resort. In January, 1935, the city leased the field, comprising 105 acres situated on the East River south of Rikers Island, on the peninsula formed by Flushing Bay on the east and Bowery Bay on the west, with an option to buy. Three small hangars stood near the shore at the northwestern edge of the property, half hidden by a hill on the east. The portion of the field available for planes was of limited size and there were no runways in the modern sense. Under the city's tenure as lessee, it was used by private-plane owners and by barnstormers as a base for short sight-seeing trips.

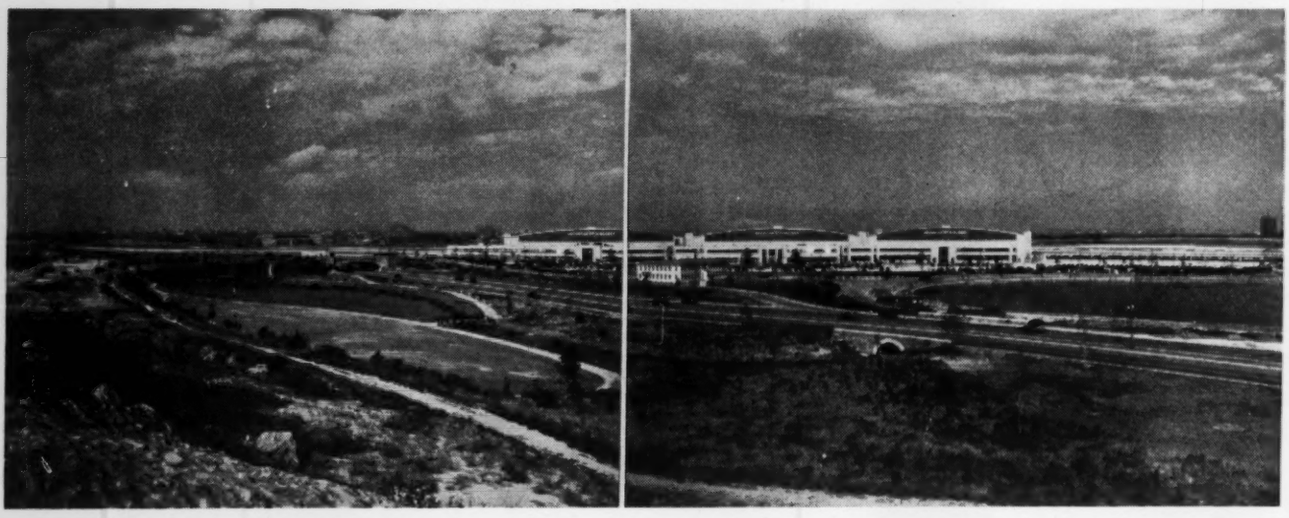
Presented at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Philadelphia, Pa., December 4–8, 1939.

A COMBINED TRANSCONTINENTAL AND TRANSOCEANIC TERMINAL

Taking advantage of the exceptional location on the Queens shore, New York City and the Works Progress Administration and its successor, the Work Projects Administration, have constructed a huge modern airport for the use of landplanes and seaplanes. Facilities for both are combined in a single terminal which will serve also as a transfer point for transcontinental and transoceanic travel. Here, passengers may make the single change necessary for the flight between all parts of the United States and Europe or Bermuda. Service from the field to Miami will connect with clippers for the West Indies and Central and South America.

In convenience to the center of the city, the site is exceptional. It is 10 min by motor from the Triborough Bridge by the Grand Central Parkway and, with the completion of the East River Drive, will be about 20 min from the Grand Central zone. It also is convenient to the Queensboro Bridge and to the new Mid-Town Tunnel. Easy access to the Bronx and Westchester County is afforded by way of the new Whitestone Bridge.

Another marked advantage of the site was that it offered an opportunity for reclaiming a large area of new land from the East River. Thus, an airport of adequate size could virtually be built to order. Instead of having to fit the airport to its surroundings, handicapped by the terrain or by the proximity of buildings, it was possible to lay out runways of ample length, giving first consideration to the prevailing winds. The



PANORAMA OF NEW YORK CITY'S

approach of arriving planes, too, could be made over the water, permitting planes to lose altitude at a distance from the field. Moreover, the buildings of the airport could be grouped on the land side, leaving the flying field entirely clear.

NATION'S LEADING EXPERTS COOPERATE ON PLANS

In laying out the airport, the best experience in the country in this branch of engineering was called upon. The Bureau of Air Commerce, the United States Army, and engineers of the important air lines contributed. The plans were drawn by the Design Section of the WPA Division of Operations, assisted by a board of consulting engineers and architects working in conjunction with the engineering staff of the Dock Department of the City of New York. A board of consulting engineers from the U. S. Engineer Corps, and another from private concerns, which had designed airports in other locations, also cooperated. The design of the field, particularly the arrangement of runways, lighting, and signals, was guided by specialists of the Bureau of Air Commerce, forerunner of the Civil Aeronautics Authority.

Extensive soil borings were made by the WPA over the entire area, both on land and under water, where fill was to be deposited. Topographical surveys were conducted to complete the information essential to developing the design. The flexibility of the plan was a consideration, so that it would provide not only for current needs but for expansion to meet future demands.

FIELD DEVELOPMENT

As originally approved, the plan called for increasing the 105 acres of the field to 429 acres through the purchase by condemnation of 96 acres of land to the southwest, and the creation of the remainder by filling in 228 acres in Bowery Bay, Rikers Island Channel, and Flushing Bay. The purchase of the 96 acres would extend the field to the Grand Central Parkway on the south and to 81st Street on the west; a hill on this property was to be cut down to the level of the airport. A new bulkhead was to be built beyond the old sea wall at the southern edge of Bowery Bay, at the western side of the field, and Bowery Bay was to be filled in to this line.

All work was to be done by the Work Projects Administration except the driving of piles, the building of the bulkhead, and certain other operations requiring heavy equipment, which was to be done by the city under private contract.

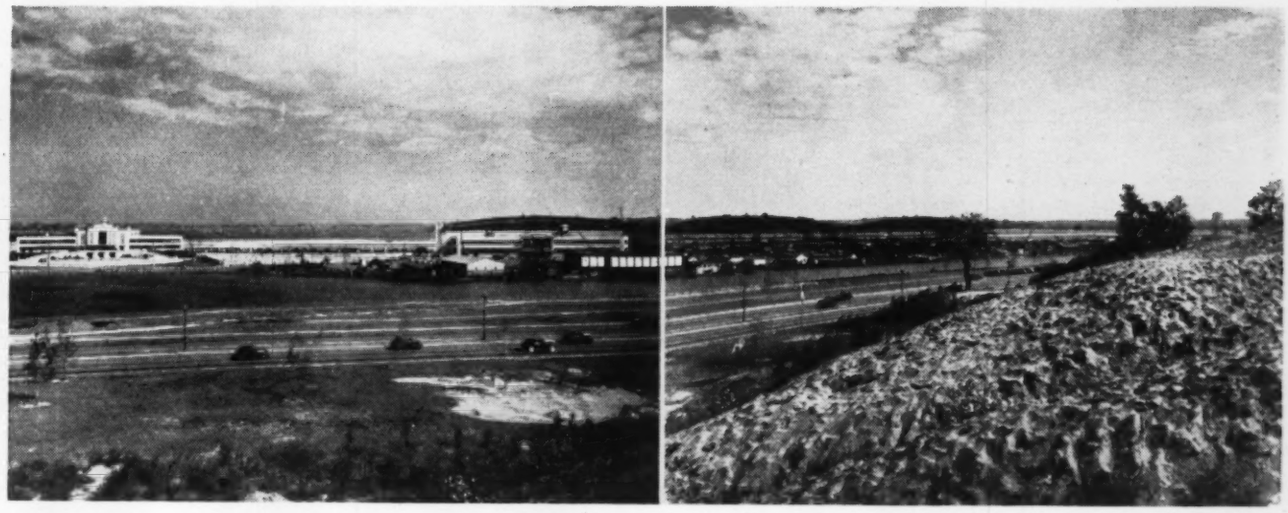
Later, after work was under way, the original plan was enlarged in order to lengthen the runways. The final plan increased the area to 558 acres, of which 357 acres, or over 60 per cent, was made land. This meant increasing the amount of fill required from the 9,300,000 cu yd originally called for to 17,300,000 cu yd. This fill was provided from the Department of Sanitation's huge dump on Rikers Island.

The architects who had drawn the preliminary plans were commissioned by the city to lay out the general plan, except the flying field proper, and to design all of the buildings and assume responsibility for the landscaping. It required many weeks to correlate the exacting requirements of the various city departments, the Board of Fire Underwriters, and the air companies, and to bring them within the budget of the WPA. The working drawings for the buildings were started at the end of December, 1937. Approximately 1000 drawings were made in the course of the following 18 months, together with the accompanying specifications. To speed up the work, WPA Administrator, Colonel Somervell, gave authority that each drawing should be supplied promptly upon completion.

The first operations undertaken were the construction of the bulkhead at Bowery Bay and a trestle over which the fill was to be transported from Rikers Island. When the trestle was finished the force employed by the WPA was increased to 5000 men. Floodlights were installed throughout the field and on that part of Rikers Island where work was in progress, the job being placed on a 24-hr schedule with the men working in three shifts, 6 days a week. When building construction began, the personnel was increased to more than 11,000, a figure which was raised gradually until, when construction was at its height in the early months of 1939, it was over 23,000 men. Under the legislation then governing the WPA, prevailing hourly rates were paid, with a fixed limit to the amount that could be earned in a 4-week period. This automatic restriction in the number of hours per month meant that a greater number of men must be assigned to the work, in shifts of a few days each, than would be working on any one day. Approximately 9000 men were working on the job daily at the peak of operations, and about this number was continued, after the appropriation act passed by Congress on June 30, 1939, fixed the hours for all workers at 130 a month.

FILLING OPERATIONS

Studies indicated that extreme care in the filling operations was necessary to prevent excessive settlement and disastrous mud waves, since the muck bottom was all under water. On



NEW MUNICIPAL AIRPORT

the basis of reports of WPA engineers and engineers of the U. S. District Engineer's office, it was decided that the level of the airport should be fixed at 12 ft above mean low water at the perimeter and 15 ft at the front of the buildings, requiring a maximum depth of fill of about 27 ft, inclusive of displacement of the silt and settlement. Because of this displacement and settlement, the estimated amount of fill required was approximately double the theoretical amount required between river bed and grade level. The fill was put in by spreading in shallow layers kept at a slope of 1 to 35 to the water line, where it was allowed to take its natural slope.

The only bulkhead included in the final plans was one 1763 ft long, of steel-sheet piling, located along the south end of Bowery Bay, where close access to the shore for seaplanes was desired. Subsequently the city had Bowery Bay dredged, by private contract, to a depth of 15 ft. The excavation and loading of the ashes and rubbish was done by as many as 40 steam shovels, serving, at the peak, a total of 400 trucks.

From the beginning of filling operations, progress was checked by aerial photographs, which by the spring of 1939, indicated that the line of well-packed fill conformed with the line drawn for it on the plans, and that the shadow of the underwater fill was well outside.

SEPARATE BASES FOR LANDPLANES AND SEAPLANES

To carry out the double purpose of the airport as a terminal for both transcontinental and transoceanic planes, two separate bases are provided, each with its own administration building and hangar accommodations. The two are connected by a taxi runway for planes and by an interior road bordering the Grand Central Parkway.

There are four great runways for landplanes, with a surface of 5-course asphalt macadam to provide for the settling of the made ground beneath them. The longest of these runways, No. 1, is 6000 ft long and 200 ft wide, oriented northwest and southeast; runway No. 2, running northeast and southwest, is 5000 ft long and 200 ft wide; No. 3, running east and west, is 4500 ft long and 150 ft wide, and No. 4, running north and south, is 3532 ft long and 150 ft wide.

These runways were designed in strict accordance with the "wind rose" or diagram constructed from the meteorological records showing the prevailing winds at the site. The 6000-ft runway is built along the line of direction of the most frequently prevailing winds; the 5000-ft runway along the line of the second most frequent, and so on.

Taxi runways, 100 ft wide, intersect the runways, connecting them with one another and with the apron, 400 ft wide and 6200 ft long, which extends in an arc in front of the land-base buildings. This apron is of concrete for a length of 2500 ft, where it is on the original ground, and of the same asphalt-macadam construction as the runways, where it is on the newly made ground. The apron in front of the loading platform is intended to provide ample space for the loading or unloading of 20 big transport planes at one time.

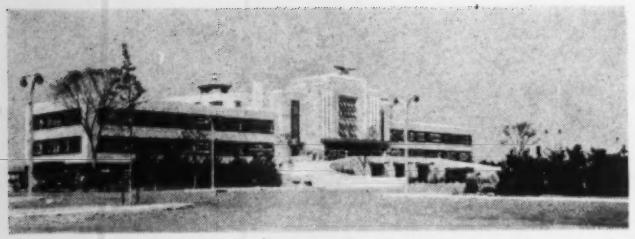
The entire ground area of the airport, except runways, apron, roads, and parking space is top-soiled and seeded with grass; the area on the parkway side is being landscaped, this work extending along the interior service road and parkways to the west boundary of the field. The words "New York" in 85-ft letters of white crushed stone stretch across the grass plots between the runways.

All buildings at the airport are supported on cast-in-place concrete piles, varying in length from 35 to 125 ft. In the case of the structures on the original ground, only the columns rest on these piles, but in the buildings constructed on fill, comprising the eastern group, the concrete floor as well is thus supported. A total of 9012 of these concrete piles was used. The pile work was done by the city on contract. All buildings are of fireproof construction throughout, with steel frames and exteriors of a soft buff-colored face brick with black brick trim.

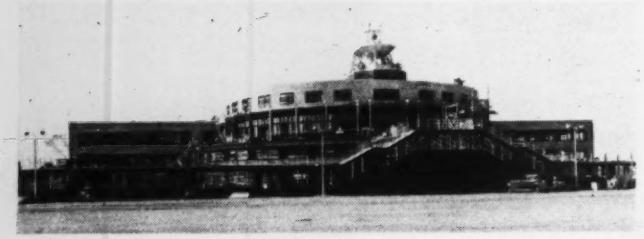
ADMINISTRATION BUILDING

The landplane administration building is circular in shape with two wings running east and west or parallel to the field. The main building is 170 ft diam and 4 stories high with the control tower above the roof. The floor of the control tower is 64 ft above the field. Each wing is 70 ft long, 60 ft wide, and 3 stories high. In this building are located a boiler room, transformer and electrical-control rooms in the basement; post office, baggage check rooms, and first-aid and doctors' quarters on the ground floor. In the east wing is the air-express space and in the west wing is the post-office space. From the ground floor are two circular stairways to the first-floor level. On this floor are located the ticket counters of the air lines, information desk, Western Union and Postal Telegraph offices in the main rotunda; in the east wing is a cafeteria and, in the west wing, the city-port-manager's offices with a suite of offices for the mayor of the city. The rotunda is carried from the first floor to a glass dome in the roof.

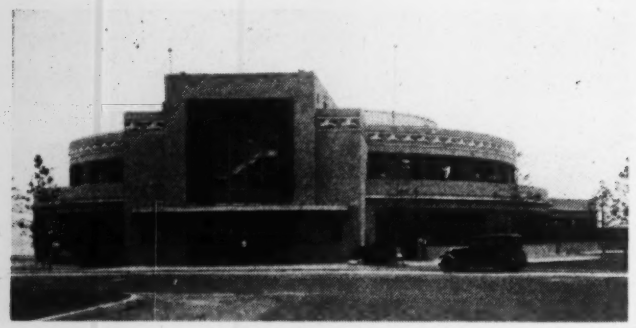
On the second floor is located the main restaurant, circular in



ADMINISTRATION BUILDING, PARKWAY SIDE



ADMINISTRATION BUILDING, FIELD SIDE



MARINE TERMINAL BUILDING, SEAPLANE BASE

shape, facing the field, with an open balcony 20 ft wide. The kitchen for this restaurant is in the east wing. A barber shop is located on this floor in the main building and a night-club room called the "Kitty Hawk Room" is located in the west wing.

On the third floor and facing the field are located offices for the weather bureau, communications, and traffic-control spaces for the Civil Aeronautics Authority. The flight-control tower for field operation is directly over and connected with the traffic-control space.

The building is built of structural-steel frame, sitting on concrete piles, cinder-concrete arches, buff-and-black face brick, backed up with terra-cotta furring tile.

The first floor and rotunda floors are of pink Tennessee marble; the sixteen columns around the rotunda are of dark-green marble. The walls are lined with glazed gray tile.

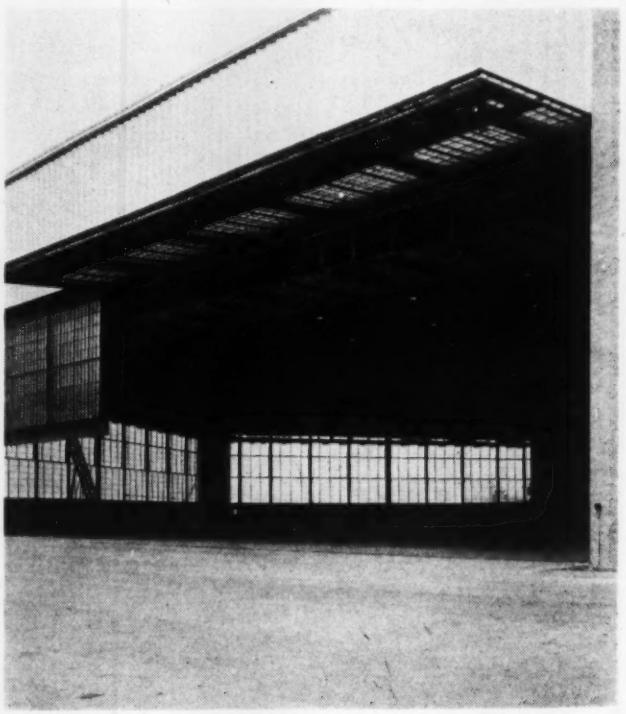
The control tower on the roof, having the floor 64 ft above the ground, is a steel-and copper structure with sides sloping outward at the bottom to prevent glare. The upper part is designed to act as a shield for the windows in a storm, and with special air-conditioning apparatus to prevent condensation. On top of this tower is a rotating double-end-type beacon of 13,500,000 cp, the most powerful beacon in the country. Also on top of the tower are installed the latest types of wind-velocity and direction indicators. These operate seven sets of indicators for the control-tower operator and various air lines. A separate set is installed on the roof for use by the Weather Bureau. An indicator from the central set is also installed in the Weather Bureau office so one may be checked against the other.

LOADING PLATFORM AND PROMENADE

Access to planes is from a covered platform of steel-and-concrete construction, 1500 ft long and 20 ft wide, which runs along the edge of the loading apron in a long arc between the two groups of hangars, with the administration building in the center. The field side of the platform is enclosed by steel panels with 40 swing doors or gates, spaced the length of the platform. These gates are divided into groups of three by dispatchers' booths and connected to the dispatchers' offices and ticket offices inside the building by a pneumatic-tube system and telephones. Last-minute word on weather conditions and other instructions and the final check-up of passenger tickets are handled at these booths. Planes will be brought up to a given gate of the platform so passengers may be enabled to embark or disembark only a few feet from the gate. A public-address system will announce arrivals and departures of planes. Stairways lead down from the concourse on the main floor to this platform, and other broad stairways lead from the concourse to the concrete promenade on top of the loading platform. It is from this upper promenade that visitors of embarking travelers or those waiting for incoming planes will watch the field. The promenade is a point of vantage, open to the public, from which it is expected thousands of persons will view the varied activities of a great airport, with a perfect view of the field at close range and yet safely out of the way of the planes. About 5000 persons can be accommodated on this platform.

SIX LANDPLANE HANGARS PROVIDED

The six landplane hangars on the field are identical in size and appearance. Each is 350 ft wide by 165 ft deep and 42 ft from ground to trusses. The three hangars of the American Airlines group have been connected into a single unit. At the parkway side, a two-story wing, approximately 1300 ft long, runs the length of the hangars, with a width of from 40 to 60 ft. The first floor houses a kitchen in which food will be prepared for



DOORS OF THE SEAPLANE HANGAR BUILDING

passengers on American Airlines' planes and employees, commissary department, pilots' training facilities, pilots' and stewardesses' lounges, shops, stock rooms, hospital, and offices. The second floor is occupied by offices and a cafeteria for employees. On the first floor of a two-story wing, 176 ft by 197 ft, at the west side of the group, are machine shops, engine- and propeller-overhaul shops and, on the field side, three engine-test cells and control rooms for testing engines after overhauling. On the second floor are located shops for instrument and radio overhaul and a lunchroom. Air-conditioning equipment has been installed in the office section of the American Airlines group, the installation comprising 22 machines and refrigeration units having a 300-ton capacity.

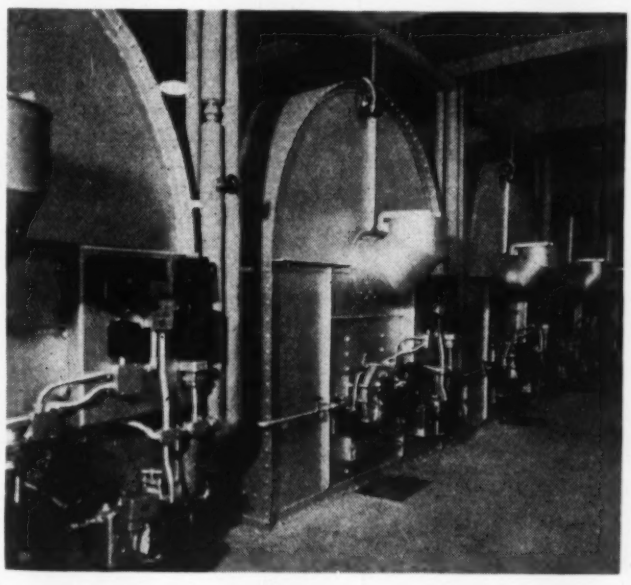
Similar wings with machine shops on the ground floor and offices above are being built as part of the hangars in the easterly group.

MARINE-TERMINAL FACILITIES

The traffic building at the marine terminal is also circular in shape, with wings two stories high, similar in construction to the land-terminal building. This building is intended to house general offices and ticket offices of the Pan-American Airways System, the Imperial Airways, Ltd., and any other foreign transport-plane companies which may wish to engage quarters. There are also facilities for agencies of the Federal Government, including immigration, health, customs, post office, and the Weather Bureau.

The marine hangar is a five-sided building with doors on four sides and shop space and office space in the rear. It is about 354 ft long with a clearance to the roof trusses of 45 ft. Planes will be brought into this hangar by means of a standard-gage marine railway, installed on a ramp extending from 12 ft below the mean low-water line and carried up to the top of the bulkhead at a slope of 3.5 per cent. From this point, the railway extends in a series of loops so that branches enter all hangar doors. Switches control the connections from one loop to another inside the building. A concrete apron 100 ft wide is located in front of the marine hangar building on all four sides.

The field side of all hangars is enclosed by four electrically operated steel-and-glass doors, hung in pairs on either side of a single steel pillar in the middle of the opening. This pillar is the only obstruction in the opening, giving a clear space on either side of 163 ft 5 in. Each door is in two horizontal sections. In opening, the lower half rises inside the upper half until even with it, giving a 21-ft opening, and then, if desired, the two sections swing out together to a horizontal position, leaving the entire 40-ft opening clear. The doors are operated by simple electric switch controls; they also may be operated by hand in case of emergency, a system of counterbalances taking the weight. The exterior space between the top of the doors and the flat curve of the roof is covered with stainless steel. The corresponding space at the opposite side of the building, between the roof of the two-story wing and the hangar roof, is fitted with a large blue-glass window which reduces heat and glare.



BATTERY OF SIX 100 HP HOT-AIR HEATERS FOR THE SEAPLANE HANGAR BUILDING

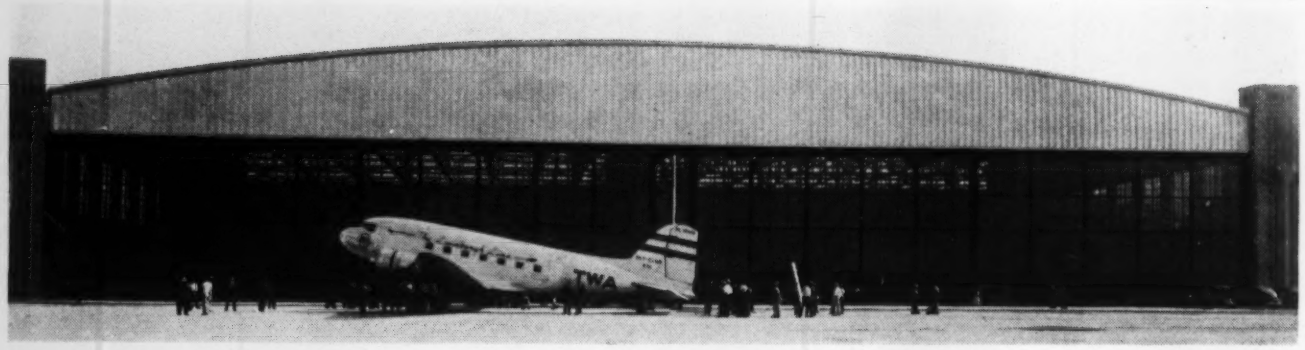
CONTROL TOWER, ROOF ADMINISTRATION BUILDING

HEATING SYSTEM

In its initial state the airport comprises seven mammoth hangars and two administration buildings, apparently ideally adapted to the use of central heating. Exhaustive studies, however, revealed that this was not the case and that individual heating of each building would prove far more economical and satisfactory. To this end each hangar was equipped with four direct-fired, welded-steel-plate hot-air furnaces, having a total capacity of 400 bhp. The furnaces are automatically oil-fired, using No. 6 bunker C oil. The seaplane hangar has six similar heaters. Each furnace has two supply-air blowers and one induced-draft fan on a common shaft driven by a 25-hp motor. The four furnaces deliver 135,000 cfm to the heating systems. Each furnace with its fans and burners is a separate unit electrically interlocked, with the necessary controls and safety devices, to the adjoining units. The number of furnaces in operation at any time is automatically controlled in accordance with the load demand.

The hangar spaces are heated to 55 F and the adjoining shops and shop offices are heated to 65 and 70 F. The system is designed to raise the temperature in the hangar spaces from zero to 55 F in 24 min, after the doors are closed. Since the hangar doors have a clear opening of 330 ft width and 42 ft height, quick restoration of operating temperatures is of primary importance.

In the hangars, air is distributed through underground masonry ducts to floor registers located along the side walls and to a continuous grating in the floor just inside of the large hangar doors. Air is recirculated back to the heaters through large grilles in the middle of the inside wall of the hangar. Air to the shops is distributed in the same way. Heated air is



LANDPLANE HANGAR NO. 1

distributed to the shop offices through a system of metal ductwork. Temperatures are automatically maintained throughout.

The two large administration buildings are heated by means of conventional two-pipe low-pressure steam systems with vacuum return. All radiators are automatically controlled by means of a pneumatic temperature-control system. Each building has its own low-pressure steam-boiler plant, consisting of two welded-steel boilers, automatically oil-fired with No. 6 bunker C oil.

In hangars Nos. 1, 3, and 5, leased by the American Airlines, the lean-to buildings were increased in size and designed to serve as main offices. These spaces are completely air conditioned for summer and winter weather. Hot air used for heating the hangars was not suitable for heating these spaces and a separate low-pressure steam-heating plant was therefore provided in hangar No. 3. These spaces are heated by a two-pipe low-pressure steam-heating system with vacuum return. All radiators are thermostatically controlled.

The various spaces are conditioned by means of 22-unit air conditioners supplied with chilled water from a central refrigerating plant located in hangar No. 3. The plant contains four 50-ton Freon compressors, two water coolers, and four evaporative condensers. A second refrigerating plant of 100 tons capacity serving nonoffice spaces, requiring air conditioning, is located in the test-shop building adjacent to hangar No. 5.

ELECTRIC-LIGHT AND POWER SYSTEMS

Electric light and power for the airport are furnished by the Consolidated Edison Company from a high-tension network system. Two services are provided to each building. The distribution systems in each building are balanced on these services, so that if one service should fail, only one half the electric facilities would be interrupted.

The Edison services come in under high tension at 27,000 v to transformer vaults; one in the landplane administration building for that building only; one between hangars Nos. 3 and 5 for hangars Nos. 1, 3, and 5, and one between hangars Nos. 2 and 4. The seaplane base, consisting of a seaplane hangar and a seaplane administration building, has one transformer vault in the seaplane hangar, serving both buildings. In these transformer vaults the service is stepped down from 27,000 v to 120/208-v 3-phase, 4-wire secondary service. Adjacent to each transformer vault is a switchboard room from which point the services are distributed over the two systems to the various buildings, each having individual distribution switchboards.

Field lighting is accomplished by flood, boundary, and obstruction lights, which have a current-supply system independent of the building light-and-power system. The transformer vault for field lighting is located in the landplane administration building.

A vast network of underground and interior conduits and cables is installed to accommodate the telephone system which is one of the most extensive ever laid out for any airport. The main service cables enter the landplane administration building which is the central distributing point for the entire system. Conduits and cables interconnect all buildings. Telephone cables in addition to being used for telephone service are used for teletypewriters and radio communication. A nation-wide hook-up of teletypewriters is used to supply information to air lines regarding weather conditions.

The entire airport is protected by means of an elaborate local fire-alarm system, interconnecting all buildings by means of a code-ringing, closed-circuit, electrically supervised 120-v a-c system. In connection with the fire-alarm system there is a crash-alarm system with air whistles and a sprinkler alarm system. The fire-alarm and crash-alarm systems are supervised from the radio control tower in the landplane administration building.

NIGHT LIGHTING OF FIELD

To the pilot of an incoming plane, at night, the field will appear dark, the edge of the field and the runway he is directed to use being outlined by means of powerful floodlights operating from the ends of that particular runway. Buildings will be marked out for him by red obstruction lights. The runways are bordered by flush-type contact lights, spaced 200 ft apart. These lights throw two beams along the runway, one horizontal and the other 15 deg from the horizontal. The intensity of these lights is controlled from the central control tower to suit weather conditions, the operator having a range of three degrees of brilliance to choose from. These lights show amber for the first 3000 ft of the runway and white for the remainder, with filters so placed that the same rule holds no matter from which direction the plane approaches the runway.

The ends of the four runways are marked by cone-type green range lights and, at either end of each runway, there are two narrow-beam floodlights, of 7,500,000 cp each. The runways and taxi runways are controlled by red traffic lights, which indicate when they are in use. Across the taxi strips, leading to the runways, are treadles which notify the control operator that a plane is entering upon or leaving that runway.

The field is outlined by 85 cone-type boundary lights, spaced 250 ft apart. These boundary lights, amber in color, are of the latest prismatic type, giving a piercing beam. They are connected on two circuits so that if one circuit fails only alternate lights will be affected.

The apron is illuminated by 5 floodlights mounted on each hangar. The red obstruction lights on top of the buildings are neon tubes with automatic switchovers so that, if one tube fails, another goes on automatically, also giving indication to the control operator that a tube has proved defective.

When a plane has landed on a runway, the floodlights and

runway contact lights go out and the taxi lights go on, showing the pilot the taxi lane by which he is to reach the loading apron and platform.

The nerve center of this entire network of lights is a desk in the control tower of the landplane administration building. This desk shows the airport in miniature. Tiny lights go on and off simultaneously with the contact, traffic, and floodlights on the field and inform the control operator when a plane crosses a treadle in moving to or from a runway. Thus, the operators in the tower literally have control of the entire lighting system at their finger tips. Lights in continual use at night, such as the boundary and obstruction lights, and the lights on roads and in the parking space, also are controlled by astronomical time switches which turn them on at sunset and off at daybreak.

The electrical wiring and controls in this room comprise one of the most intricate and efficient systems ever installed. This extensive and complex lighting system required the laying of a network of underground cable in ducts covering the entire field. Approximately 800,000 linear feet, or some 160 miles of duct were laid.

Bowery Bay is illuminated by two banks of floodlights so situated that the pilot, whether taxiing in or out, will not get the glare in his eyes. Each of these banks comprises three floodlights of 3000 w each or 18,000 w for the two banks. Lighting at the marine terminal, including the terminal building, hangar, and the floodlights on Bowery Bay, is controlled from the terminal and also is tied in with the landplane administration building so that the entire airport operates as a single unit.

At the north end of the airport is a 22-ft wind T which gives the pilot the direction of the wind to aid him in landing. This wind T is electrically illuminated for night use. It is connected with an indicator on the control desk in the control tower as a double check for the operators against their other indicators operated from the roof of the tower. This wind T can also be set by the operator to aid the pilots when the wind velocity on the field is too light to operate it mechanically.

EQUIPMENT FOR INSTRUMENT LANDING

At present, only runway No. 2, the 5000-ft runway, is equipped for instrument landing. The transmitting station for this is behind Calvary Cemetery in Maspeth, L. I., 3.8 miles from the southwesterly end of the runway. The system used is known as the SMRAZ-D unit.

When the pilot passes over the transmitting station, he receives a high-frequency note informing him of that fact, the note coming from a transmitter known as a Z marker. Halfway between the transmitting station and the airport is another Z marker. These two Z markers give him his exact distance from the runway. From this and his altitude, he can compute the gliding angle. The pilot can come in on the same beam from the northeast; Z markers for his guidance are placed at College Point.

This runway is also equipped with approach lights on the southwest end. These approach lights are 7-ft neon tubes spaced 200 ft apart and carried across the Grand Central Parkway on a line parallel with the runway for a distance of 3000 ft.

Provision also has been made in the plans for equipping the 6000-ft runway, No. 1, for instrument landing. According to the plans, it is proposed to use the Bendix-Benz beam system on this runway. With this system, the pilot is kept on the beam by watching two dials on his instrument board, instead of listening through his earphones.

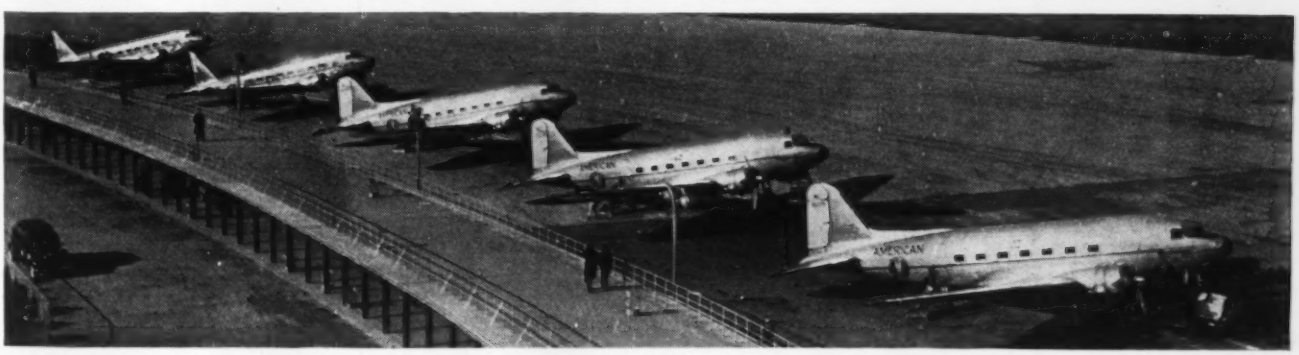
Auxiliary power outlets for radio, light, or power use are located at either end of all runways. All radio receivers, including those of the airport itself and those of the air lines, are located on Rikers Island in order to eliminate electrical interference from automobiles and machinery. A 200-pair submarine cable connects the towers on the island with the control tower on the landplane administration building, from which distribution is made to the operating offices of the air lines, where they are amplified. The radio transmitters for the airport control tower also are in the landplane administration building; those for the air lines are located in the marshes of Jamaica Bay, along Cross Bay Boulevard, some 15 miles from the airport and are connected with it by telephone company wires.

Provision is made for bringing gasoline to the airport by water in tankers and discharging it directly into storage tanks by pipe lines. At the westerly edge of the field, near the bulkhead, is a gasoline-storage building, housing eighteen 20,000-gal storage tanks with the necessary pumps, foamite equipment, and loading apparatus. This will serve the Pan-American Airways hangar by pipe line and, by truck, the eastern group of hangars at the landplane base. Gasoline will be pumped into these tanks direct from the tankers brought up to the bulkhead in Bowery Bay. A separate gasoline-storage building has been erected for the American Airlines, to the west of its hangars. This has seven 15,000-gal tanks, with all the other necessary equipment. These tanks also will receive their gasoline through the same pipe system from Bowery Bay.

SUBSURFACE AND STORM-WATER DRAINAGE

The airport has two drainage systems, a subsurface system to take care of the ground water and a surface system to drain off storm water. The subsurface system is complete for the apron and runways, and crossovers have been installed under the runways so that surface drainage for the field may be installed at any point at any time without interfering with the traffic of the airport.

The subsurface drainage system, designed to lower the ground water table, comprises broken-stone trenches and 6-in.



GIANT FLAGSHIPS LINE UP ON LOADING RAMP

perforated corrugated-iron pipe on each side of all runways and taxiways. The water flows into junction basins, constructed about 400 ft apart and is carried off through concrete and vitrified-tile pipes, ranging from 8 to 36 in. in diam, emptying into the river and the two bays through 14 outlets around the perimeter of the field.

The storm-water drainage system is designed for a run-off of 1 in. per hr, a capacity about double that required for most hard storms in this locality. Brick catch basins from 3 ft 6 in. to 4 ft 6 in. inside diam and from 4 ft to 12 ft deep, fitted with cast-iron covers, are located about 200 ft apart along the edge of the apron and roadways. These drain into the same pipes that carry the ground water to the river. With corrugated-iron cross-over pipes already installed under the runways, at a depth of from 8 to 10 ft, and the large-diameter pipe already installed at the sides of all runways as a part of the subsurface drainage system, brick catch basins can readily be put in anywhere in the field as needed.

Sanitary sewers connect all buildings with the new city sewer running across the southwest corner of the field and emptying into the new disposal plant being built by the city to the west of the airport.

Water supply is furnished by one 12-in. and one 16-in. main feeding a 24-in. main for the landplane base and two 12-in. mains feeding a 16-in. main for the marine base. The two systems are interconnected by a 16-in. main so that, if one fails, the other can supply both bases.

At the landplane base, the 24-in. low-pressure line continues to the administration building and from this point is decreased to an 18-in. main for the hangars to the east. The 24-in. low-pressure line branches at a pumping station located between hangars Nos. 3 and 5, to feed tanks and pumps by an 18-in. line. From the pumping station, a 24-in. high-pressure line, with a pressure of 100 lb per sq in., feeds to all buildings in both landplane and marine bases for fire protection.

At seven points along the line, steamer connections are provided so that in case of failure of the pumping station the New York City Fire Department can connect to both high- and low-pressure lines and build up the high-pressure line.

Plumbing arrangements include shower rooms in each hangar for the use of pilots and other employees and men's and women's toilet rooms on each floor of both the landplane administration and the marine-terminal buildings.

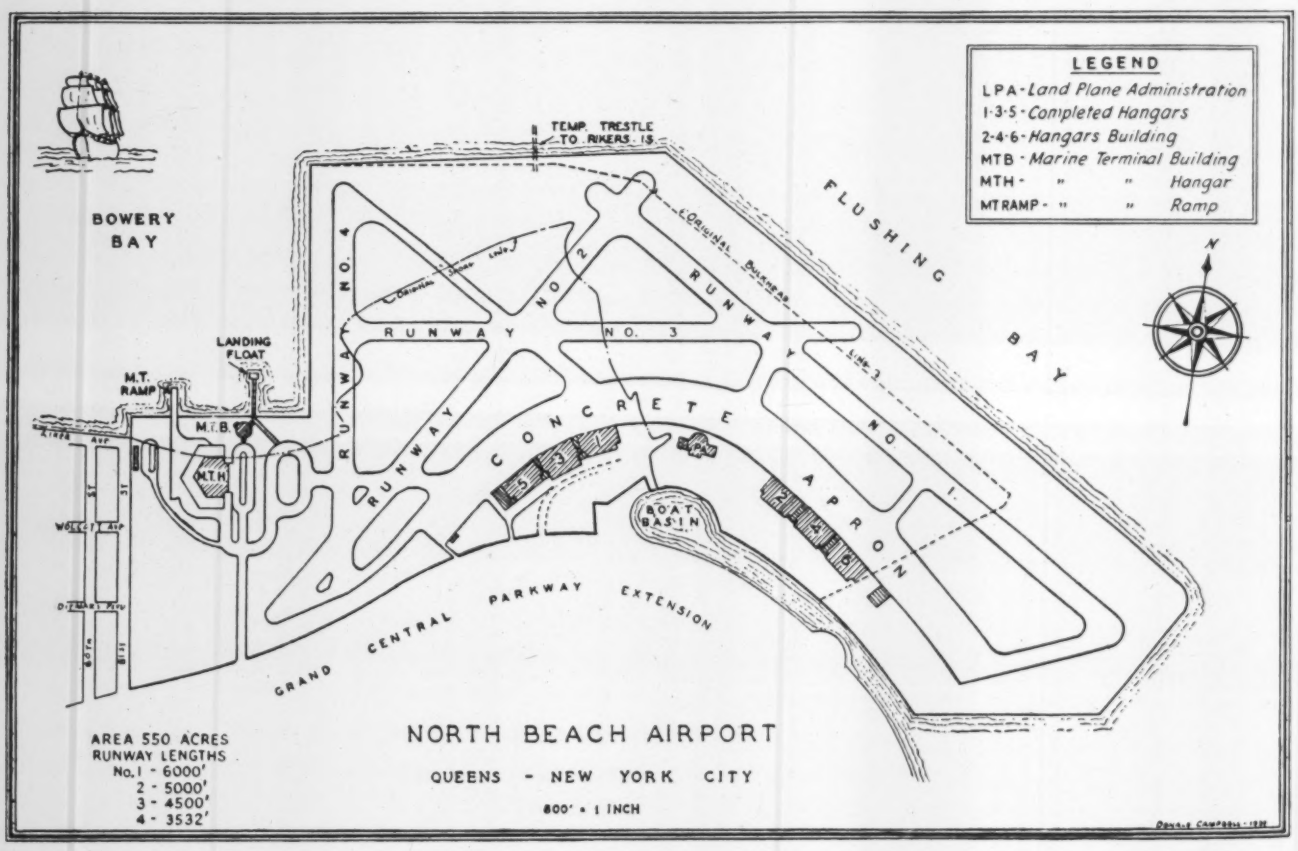
All of the buildings are fully equipped with the latest automatic sprinkler systems, the hangar areas with a deluge system which is operated by a rate-of-rise method, the office and shop areas of the hangars with a standard wet-pipe system, controlled by a variable-pressure alarm valve. The operation of any sprinkler valve will sound a code number, indicating the building, on all fire-alarm gongs, will record and time-stamp the code number on the register in the port-manager's office, and sound a bell in the building in which the operated valve is located. There is a city fire-alarm box in each administration building.

Upon completion of the airport all areas not covered by buildings, roadways, aprons, parking areas, etc., will be planted and seeded. This means approximately 375 acres of planted ground upon which have been placed 500 trees, and 275,000 cu yd of topsoil.

When this airport is completed, which will be early in 1940, it will be the finest airport development in the United States. The total cost will probably approach $40,000,000, one third being contributed by the City of New York and two thirds by the Federal Government.

There is also room for expansion to include three more hangars, two utility buildings, a hangar and office building for the Civil Aeronautics Authority, and a hangar for transient fliers.

The total time for development of the entire project has been approximately $2\frac{1}{2}$ years.



Recent PROGRESS *in* AERONAUTICS[1]

I—Progress in Aerodynamics

By CHARLES TILGNER, JR.

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ISOLATING one small period of progress in a subject which flows on continuously is difficult, but a little indulgence on some matters which perhaps rightfully belong to 1938 or 1940 will ease the task.

Perhaps the outstanding development of the year has been the laminar-flow airfoil. Preceding this was the discovery that the inherent turbulence present in most wind tunnels had obscured the possibilities of producing laminar flow on an airfoil. The practical application of laminar flow to the wings of actual airplanes should be a development of the near future.

Investigation of the effect of surface texture on commonly used airfoils has shown that irregularities of any type are important on the forward 30 per cent of a wing, which is the portion that may have laminar flow. On the afterportion, rivet heads and surface roughness have a small effect, but slight waviness seems to produce no change in drag.

Compressibility has been a much-discussed topic during the last few years, but it was only during 1939 that any information which will actually improve the performance of an airplane has been made available. Data have been compiled on a number of component parts of the airplane and improved shapes have been developed for increasing the speed at which compressibility effects become critical.

The problem of cooling the engine of an airplane in flight with a minimum of aerodynamic disturbance has been attacked from many angles, and has resulted in several interesting arrangements. Data for radial-engine cowlings which have already been published emphasize the need for careful shaping of the external lines, especially in the region of the nose. Internal shape in the nose portion is unimportant due to the low velocities present. The exit slot must be carefully designed both as to shape and area.

Propeller design has kept pace with the increased speeds by employing blade sections with reduced drag and compressibility effects. In a practical way, some work has been done on the use of propeller cuffs to improve the cooling of engines in a climb and on the ground. The cuffs accomplish this by covering the round shanks of the blade with an airfoil section, thus increasing the dynamic pressure near the center of the propeller disk. Cuffs may also reduce compressibility effects on the blade shank at extremely high speeds. Spinners have been tested in many forms, with a resultant increase in maintenance difficulties and a possible small increase in aerodynamic efficiency.

Unfortunately, as speed increases, gust loadings and the tendency to flutter are both increased. Further work has been done on the measuring and compiling of load factors due to gusts encountered in routine flight operations. Also, by the use of models, a better understanding of the gust problem is being obtained. Flutter theory has long been well developed, but recent developments in the technique of flutter model testing, particularly in the use of new materials for the model, have provided a noteworthy advance.

A new parameter which has been introduced this year is the spin design criterion. By means of areas and arms picked off a side view of the airplane, a "tail-damping power factor" is obtained which seems to effect a satisfactory separation between good and poor spinners. The critical value is based on results obtained from numerous modern airplanes, the spinning characteristics of which are known. The value of this factor will be determined by the results obtained on future designs.

The tendency toward higher wing loadings has necessarily given a great impetus to the investigation and further development of high-lift devices. Interest seems to have been centered on the trailing-edge flap in many forms. No outstanding development in this field has been announced as yet, but the design information for conventional flap arrangements has been considerably expanded and improved.

It is obvious that most of the research in 1939 has been aimed at speed—and still more speed. Pilots have long complained that the designer's only interest has been performance, and consequently the flying characteristics of airplanes have not kept pace with other developments. Perhaps this is true, but the lack of parameters for flying characteristics has undoubtedly contributed to this condition. During the last year, considerable time and effort have been expended on the correlation of airplane flying characteristics and pilot's reactions. It is to be hoped that this will lead to design criterions which will give the designer an objective almost as definite and precise as miles per hour and pounds.

It will be extremely interesting to note what effect the war in Europe will have on aerodynamic development in 1940.

II—Airplane Design Progress

By RICHARD M. MOCK

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THOUGH no single outstanding airplane design features appeared in 1939, the year might be listed as a landmark in airplane development because of the great increase in airplane production toward the end of the year brought about by the increased armament procurement in the United States of America, and by military orders for export. More than ever, attention was given to designs permitting quick and cheap production in large quantities; large quantities in comparison with former years, though small in comparison with automotive and other industries. In 1939, for the first time, single orders were placed for 200 to 400 of one type plane, permitting manufac-

[1] Progress Report of the Aeronautic Division presented at the Annual Meeting, Philadelphia, Pa., Dec. 4–8, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

turers to incorporate design refinements hitherto considered impractical. Most of these improvements were in detail design to facilitate manufacture, assembly, and installation. Outstanding was the increased tendency toward unit assemblies allowing a large number of men to work simultaneously on various units that could later be assembled. The type of plane requiring a large number of men to try to work in one place at one time in order to make necessary installations was gradually fading into the past.

In general arrangement and in major details new airplanes changed little in 1939. Possibly the main reason for this was lack of time for development and test of new features, in view of the great demands for quick deliveries of large quantities of types havin features already proved.

On the new types developed in 1939 wing loadings continued to increase. However, the practice was to calculate the wing loading with flaps retracted and not in landing position. This is correct for consideration of the effect of wing loading on cruising and maximum speed. However, since many new planes used flaps that increased the wing area, as the Fowler, the wing loading should be based on the extended area when considering the effect on landing and possibly take-off performance. With these considerations in mind it can be pointed out that landing speeds did not increase appreciably; while high speeds, especially on military types, went up remarkably. Speeds well over 300 mph were not uncommon. These increases in speed were due only in part to increased wing loadings, as most of the increased speed was due to lower power loadings made possible by the availability of more powerful engines. Aerodynamic refinements contributed only a small share to this increased speed. These aerodynamic improvements were mainly general cleanup of the airplane, improved external lines, elimination of external excrescences, and improved surface finishes with flush riveting.

As the year came to a close more attention than ever before was given to the design of engine cowlings and engine installations. These seem to offer the greatest possibilities for increased performance without great increases of power or sacrifice of wing area, or radical rearrangement of the airplane. Many fundamental data on cooling of radial air-cooled engines were accumulated and it is impossible to predict how they will be applied. Studies in heat transfer were also applied to radiator designs and installations, both for radiators for liquid-cooled engines and to oil radiators for all types of engines. Shaft drives, as developed for the new 18-cylinder twin *Wasp* engine and for the Allison engine, gave airplane designers new possibilities for the application of ingenuity in the general configuration of the airplane. An example is the Bell XP-39 single-seat fighter tractor-propeller drive by a shaft from the engine mounted behind the pilot.

Landing gears on all new types were fully retractable, including the tail wheel. On the higher-performance airplanes of 1939 this was of importance; while on slower machines of former years the partially projecting tire or completely external tail wheel did not reduce the performance appreciably. Nose wheels continued to increase in use, though the need to get into production on developments of former types without the delay of designing and testing new features eliminated such new features on some types. Nevertheless, nose wheels were used on such new planes as the Douglas DC-5 twin-engine transport, Douglas DB-7 twin-engine attack bomber, Lockheed P-38 twin-engine single-seat fighter, North American NA-40 twin-engine bomber, and Stearman-Boeing X-100 twin-engine attack bomber, as well as the Bell XP-39 single-engine pursuit and Vega transport, and nearly all new projects including the Lockheed four-engine *Excalibur*, model 44. Improvement in landing brakes which were made by Bendix, Hayes, and Goodyear added considerable impetus to the development of the nose wheels.

Perhaps the most significant milestone in 1939 was the completion of the final tests on the Boeing 314, a 95,000-lb four-engine flying boat, and the inauguration of transatlantic and transpacific passenger services using these planes.

Contrary to the trend of previous years, the tendency was not toward larger airplanes. Possibly this was due to the need for quick delivery of developments of existing types. Four-engine military machines were produced for the military services, but it is felt that if equivalent power in larger engines had been available, many of these planes might have been two-engine types. In the civil field, because of improved performance with one engine inoperative, there was a definite trend toward four engines, though the size of plane was not as large as that indicated at the end of 1938. The DC-4 prototype tested in 1938 and 1939 weighed 62,500 lb, but the production machines ordered for delivery in 1941 are to be 50,000 lb gross weight, with accommodations for 40 day passengers, or 20 by night. The new transports of Boeing, Curtiss, and Lockheed are all in the 35,000 to 45,000-lb class.

All of the new long-range and medium-range civil transport types under development are being designed to have supercharged cabins. As this is written, the C.A.A. tests are being run on the first civil type with provision for pressure cabin, the four-engine Boeing 307. The twin-engine Curtiss-Wright CW-20, with provision for pressure cabin, is expected to be completed early in 1940; while the Lockheed *Excalibur* four-engine transport with pressure cabin is not expected to be completed until the summer of 1940. All of these planes, like the production DC-4's, are designed for operation at 20,000 to 25,000 ft, with cabin pressure equivalent to 8000 ft. Of significance were the flights, in October, 1939, of the pressure-cabin four-engine Farman NC-2234 mail transport across the South Atlantic at an average altitude of 25,000 ft. Though external drag of the airplane was such that there was little gain in performance due to the high-altitude operation, the actual service operation of a pressure-cabin type was significant.

One of the greatest contributions in the multiengine field was the full-feathering propeller. The increased safety due to this device is a definite advancement. Though developed before 1939, it did not come into general use until this year, and its immediate general adaptation indicates its importance. Full-feathering propellers were made by both Hamilton Standard and Curtiss-Wright. Though aluminum-alloy blades continued in general use on civil transports, the lighter, hollow, steel blades were used in increasing quantities on military types. The Curtiss-Wright four-bladed controllable propeller was a notable contribution along with the Curtiss-Wright reversible-pitch propeller (for maneuvering flying boats) and the blade-shank cuff (for improved take-off thrust and better cooling on radial engines).

The research by Lockheed on fixed wing slots was of importance, and its adaptation to certain transport designs was a contribution to safety.

Another significant work for increased safety was the research by the Douglas Aircraft Company and the U. S. Bureau of Standards (under the C.A.A.) with the cooperation of the air lines and government services in the study of fire reduction and fire suppression. The development of fire detectors, as well as a suitable oil-shutoff valve, suitable oil connections, and fire-extinguisher distributor systems, will have important effects in future airplanes.

Though few details were published on new airfoils, the new wings of the N.A.C.A. are expected to bring about a general improvement in performance, though none are yet in actual service. The Davis wing used on the Consolidated model 31,

large, twin-engine flying boat attracted considerable attention. The boat, with its high wing loading, high useful load, and excellent performance, is a notable advancement in design. The Davis wing is an empirical airfoil for tapered wings evolved by David R. Davis.

Another important advancement in design was the Douglas DC-5 which appeared in February, 1939. This twin-engine transport, which was designed for short-haul passenger operations in and out of small fields, was especially interesting with its high wing location, low wing loading, nose wheel, and interesting structure, with single spar wing and fuselage bulkhead arrangement with a protection keel in the bottom of the fuselage.

Another interesting design was the Vought OS2U-1, Navy, low-wing, spot-welded, aluminum-alloy monoplane with "deflector-plate" flaps on the trailing edge of the wing for increased lift, as well as drooping ailerons for the same purpose. Another feature was "spoilers" in the wings to supplant the ailerons at low speed.

In 1939, as in previous years, the ratio of pay load and useful load to gross weight remains about constant in spite of continual advances in structural refinements. Perhaps the reduction in weight of primary structure was offset by the fact that the primary airplane structure is not a large percentage of the total empty weight and by the increasing number of installations of equipment and accessories which are grouped with the empty weight. Primary structures, in most part, continued to be of Alclad riveted in a semimonocoque arrangement with continuous stringers and bulkheads. Spot welding attracted as much attention as ever, but was still used only in limited applications. Of interest was the increasing number of small planes with fuselages made completely of welded steel tubing and those in which merely the forward section, where accessibility during manufacture is important, was of this construction. These planes had removable metal side panels and the rear portion of the fuselage of the semimonocoque type. This arrangement was first applied experimentally in the Douglas X 02D-1 built for the U. S. Navy in 1934.

In 1939, plastics attracted considerable attention, especially the Clark-Duromold airplane built in 1938. Most of these so-called plastic airplanes were merely formed-plywood machines using glues in the phenol formaldehyde class. The purely plastic airplane structure has not yet made its appearance.

Hydraulic controls increased in use, and with improved technique acquired in recent years, the trend was definitely toward increasing the former pressures of 500–1000 psi to pressures in the neighborhood of 2000–3000 psi, or more. Though designers seemed in agreement regarding the desirability of alternating-current electrical systems, press of time for quick delivery and increased cost of special electrical equipment caused many designers to stay with 12- or 24-volt direct-current systems. High-pressure hydraulic systems and high-voltage, alternating-current electrical systems seem two of the most potential means of weight reduction in large airplanes.

III—Development in Aircraft Power Plants

By C. FAYETTE TAYLOR

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THE development of air-cooled radial engines of more than 1500 hp, which has been under way for the last two or three years, has finally culminated in the announcement of an 18-cylinder, 2000-hp engine by the Wright Aeronautical Corporation, and of an 18-cylinder engine by Pratt & Whitney rated at 1600 hp at 20,000 ft altitude. The 1500–1600-hp 14-cylinder Wright engine was released for export sale in October, 1939, at which time constructional details were published.

The power section of these engines follows previous practice rather closely, but the Pratt & Whitney engine contains a rather radical departure from previous practice in its very long "nose," designed to carry the propeller at a considerable distance forward of the cylinders. The purpose of this arrangement is to make possible better streamlining of the engine nacelle and to reduce the drag required to cool the power plant. One type of cowling which may be used with an engine of this type was shown at the New York World's Fair. This cowling has a much sharper entrance than previous cowlings for air-cooled radial engines, and the air intake consists of an annular slot located several feet behind the propeller disk. This type of cowling is the result of work by the National Advisory Committee for Aeronautics and details of its construction and performance have not been released. Its general appearance, however, would lead one to believe that a considerable reduction in drag may have been achieved, as compared with that of the "standard" N.A.C.A. cowling now in general use.

A renewed interest in air-cooled engines with cylinders in line is indicated by at least one installation of the Ranger 12-cylinder Vee type in an experimental military airplane. This engine is rated at 500 hp for take-off and for climb up to 1700 ft altitude. The normal cruising output of 300 hp can be maintained up to 10,500 ft. It will be interesting to watch this development, and especially to see how well such an engine can compete with radial engines of similar power output.

The Allison 12-cylinder 1000-hp liquid-cooled engine appears to have proved satisfactory to the military services, and large orders have been placed with the manufacturers for this type. It is understood that considerable development work is being done on long drive shafts to be used in connection with installations of either the pusher or tractor type, in which the propeller is located some distance from the engine itself. Such an installation appeared some time ago in the Bell *Airacuda*, but it is understood that the need of further development was indicated by this installation. A 24-cylinder 2000-hp Allison engine was shown at the New York World's Fair. This engine is made up, essentially, of two of the 12-cylinder models with a common crankcase and with crankshaft geared to the same propeller shaft. This cylinder arrangement does not appear to be particularly compact when compared with the 18-cylinder radial engines of equal power, but only service experience can show definitely the relative merits of the two types.

The numerous light plane engines in the 50–75-hp class, which were announced a year or more ago, have proved in most cases to be both reliable and otherwise satisfactory for this type of service. Airplanes requiring engines of this general class are being sold in surprisingly large quantities, and the new C.A.A. program of pilot training should make this class of equipment even more popular.

Another year has gone by with no major developments in the airplane Diesel-engine field and meanwhile reduction in the fuel consumption of gasoline engines of large size has reached a point where the advantage of the Diesel in this particular respect has virtually disappeared.

In the field of propellers progress has been made in the de-

velopment and refinement of pitch-changing and feathering mechanisms but, fundamentally, design remains unchanged. The use of steel blades has become more general, and it appears that this material may be a strong competitor of the traditional duralumin. In spite of the promising characteristics of some plastic or plastic-wood combinations, none of these has yet come into general use for propeller blades.

The intensive work on the study of power-plant vibration which has been carried on by many agencies during the last few years has now reached a point where the vibration characteristics of engines, propellers, and crankshafts are now fairly well under control, if not entirely understood. Vibration studies of each particular engine and propeller combination are now considered a matter of routine, at least for the larger power plants, and thanks to this work, propeller and crankshaft failures due to vibration have been practically eliminated. Much progress has been made in isolating the airplane structure from engine vibration by suitable shock-absorbing mountings.

With the higher altitudes at which both military and commercial airplanes are to be flown in the near future, the need for cabin supercharging has become apparent, and much development work has been done during the last year on this problem. It must be admitted, however, that considerably more study and research must be undertaken before an entirely satisfactory "pressurized-cabin" system is available. Development of small auxiliary engines for driving generators and cabin superchargers has been continued through the year, with one or two types beginning to emerge from the first experimental stages.

IV—Development in Aviation Accessories

By R. P. LANSING

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IN LINE with the development of aviation engines of higher horsepowers, it has been necessary for the development of engine accessories to keep pace.

As engines increase in horsepower likewise it is important that accessories be capable not only of high capacity but also that they have suitable ruggedness and durability. For instance, during the last year starters have been made available for engines up to 2000 hp in both direct-cranking electric types and inertia starters. On the other extreme, the same type of development work has been carried on to provide for engines as small as 50 hp. In another direction hydraulically operated starters have likewise been made available.

As for the electric power supply, the chief progress has been the making available of high-capacity generators in small size and weight. Generators are now available for standard application up to 160 ampere output in both 15- and 30-volt varieties. Radio dynamotors have been improved in efficiency, particularly as regards weight and size.

The accessory-engine development has progressed satisfactorily and lightweight power plants are now available ranging from 5 kw direct current, up to 17½ kva in alternating-current types. These are of both the air-cooled and Prestone types.

Power supply has been put into actual use both in alternating and direct current, with perhaps a dominating interest at this time toward 24-volt direct current.

Magnetos have likewise been improved for refinement, particularly in connection with radial engines. Of marked interest are the new developments in magneto, spark-plug, and harness shielding.

The application of hydraulics has made rapid progress for various controls and actuated mechanisms in conjunction with the modern plane development, although the use of the equivalent electric accessories has kept stride with the progress in hydraulics.

As for instruments, the remote-reading indicators are being developed for greater accuracy and durability, and are making progress in general application. New developments are in progress which will make remote indication available for important instrument functions.

There has been a marked improvement in fuel-induction systems. The new carburetors in general use have contributed remarkably to safety, eliminating ice formations as well as improved economy, and work on fuel injection looks promising for its future use.

V—Aviation Radio Developments

By W. P. HILLIARD

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THE automatic radio compass with its numerous advantages is replacing the aural null direction finder in the domestic air-line operation. This device provides practically instantaneous automatic azimuth indication throughout 360 deg and is of great value to the air-line pilot since a cross bearing or position "fix" can be made with minimum effort. The chance for human error is greatly reduced due to automatic null-seeking feature. In addition, when the radio compass is tuned to an off-course station, a continuous visual position indication is obtained which is very reassuring to the pilot. Introduction of the automatic radio compass was a logical step forward from the "left-right" indicator-type compass which is still in wide favor as a visual homing device. The principle of operation of these two types of radio compasses is much the same except that in the automatic type an electric motor, controlled by the receiver output, is provided for rotating the loop to the proper bearing position. The use of this type of radio compass, in conjunction with a magnetic compass, earth-inductor compass, or directional gyro, makes drift calculations quite simple. Consolidation of an automatic radio compass and some form of magnetic compass or gyro is contemplated by many in the industry.

A new terrain clearance indicator is offered commercially that is a distinct contribution to the aviation progress. This unique device indicates to the pilot the clearance between his plane and the terrain over which he is flying. This is of inestimable

value when flying "on instruments" over unfamiliar territory. The principle on which the instrument operates is not new but its application was delayed until vacuum tubes were developed capable of satisfactory operation on frequencies above 500 megacycles. The equipment comprises a transmitting and receiving system so arranged that a meter indicates the transit time required for the transmitted wave to reach the earth and be reflected back to the plane's receiver. The directly calibrated indicating meter has a maximum range of 5000 ft, which is considered adequate for the intended service.

One of the most important developments of the last two years has been the extension of the C.A.A. type certification to cover every item of air-line radio equipment. This has done much to eliminate poorly designed or overrated equipment from the air-line field and has insured the reputable manufacturer against unfair competition. Every item of radio equipment which the C.A.A. requires the commercial air line to carry must undergo and pass the severe C.A.A. type-certification tests. These tests are designed to insure the purchaser that equipment bearing a C.A.A.T.C. number will withstand all operating conditions encountered in commercial air-line service.

During the last year, precipitation-static-suppression equipment has been made commercially available. Used in combination with a shielded-loop antenna, it has been found to be a practical answer to precipitation static elimination during radio-range reception. On communications frequencies, where shielded-loop antennas are not usable, the precipitation-static-suppression equipment has been used with gratifying results.

Progress has been made in the application of Adcock-type ground-station direction finders, operating on air-line communication frequencies. The C.A.A. has contracted for three such installations to be installed in the eastern part of the country. These equipments are unique in that they have automatic visual bearing indication and can be remote controlled. Considerable work has also been done with the spaced-loop type of ground-station direction finder. Future investigation will be toward such a direction finder operating on ultrahigh frequencies.

Major advances have occurred in the application of ultrahigh frequencies to aviation radio problems. Receivers and transmitters covering the assigned aviation channels will soon be available. An outstanding contribution has been the application of frequency modulation to aircraft ultrahigh-frequency equipment. The expected advantages are better range and lighter installations. The C.A.A. has been active in this field, particularly with respect to radio ranges. A contract has been let for ten UHF range installations to be used in actual navigation. Three UHF traffic-control transmitters are on order.

Instrument-landing development has been intensive, although few actual installations have been made. The Indianapolis installation of the C.A.A. is practically complete and includes the novel feature of controllable-glide path shape. This is accomplished by varying in azimuth the directivity of the glide-path-transmitter radiation pattern. The results obtained give promise of commercial application. Progress has been made on an instrument-landing system operating on approximately 600 megacycles and using horn-type radiation. The C.A.A. intends to contract for ten installations in the near future, and at present the National Academy of Sciences, acting in an advisory capacity, is making a study as to the best system to be used for the ten proposed installations so as to give maximum usability to all prospective services and to unify the construction programs of the C.A.A., the Army, the Navy, and others.

VI—Development in Meteorology

By ATHELSTAN F. SPILHAUS

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MUCH of the development in meteorology during the last year may be attributed to the directing policies of the new chief of the U. S. Weather Bureau, Commander Francis W. Reichelderfer, appointed at the beginning of 1939 to succeed the late Dr. Gregg. While Commander Reichelderfer has stressed the fact that the valuable services which the Weather Bureau renders agriculture, engineering, and other fields will be given no less emphasis in the future, nevertheless it is a good augury for those particularly interested in the development of meteorology in connection with airplane operation that his previous work was in pioneering the development of meteorological services essential to aviation. More particularly, it is opportune that with the development of trans-atlantic flying there should be a chief of the Bureau whose especial association has been with ocean weather.

It is unfortunate that, with the stage thus set for sound rapid development of the ocean weather service, the major catastrophe of the new world war should have interfered with its prosecution. Meteorological information is, however, becoming a more and more important factor in military strategy, and the effect of the present conflict is not only to cut down the network of generally available ship reports from the Atlantic but also to eliminate from general distribution the data from a large section of the Canadian observing stations. This materially affects the forecasts for the eastern part of this country. While the decrease in available Atlantic data seriously handicaps those making predictions for transoceanic flying at the present time, it may ultimately be beneficial, such that in taxing the ingenuity of the analysts, they will be forced, not only to make the best use of the data, but also to insist that the quality of the weather reports from ships at sea be improved.

About thirty radio-meteorograph stations have been established, and while at first certain large errors in the data rendered them useless, the network is now functioning satisfactorily, ascents being made at all these stations up to an average height of over 15 km daily. It is to be hoped that in the case of the general predictions rearrangement of the times of their issuance will permit the forecasters to make complete analyses in the light of this upper-air information and ultimately to issue deliberate forecasts rather than rush forecasts made necessary by a stringent time schedule. In connection also with the general weather forecasts, a progressive trend is to be noted in the establishment of a new Weather Bureau forecast center at Kansas City. One may trust that this is indicative of a policy of decentralization of forecasting so that the burden of predicting for a large area will not be placed on meteorologists located at so distant a point that cognizance of local effects for certain regions are sometimes overlooked. Such decentralization will enable forecasts to be more specific and, therefore, more useful to the many uses to which weather predictions may be put other than aviation. The principle of decentralization has long been operative in the airways forecasting service with marked success, but unless the same policy is adopted in regard to general forecasts the growth of free-lance weather-forecasting services

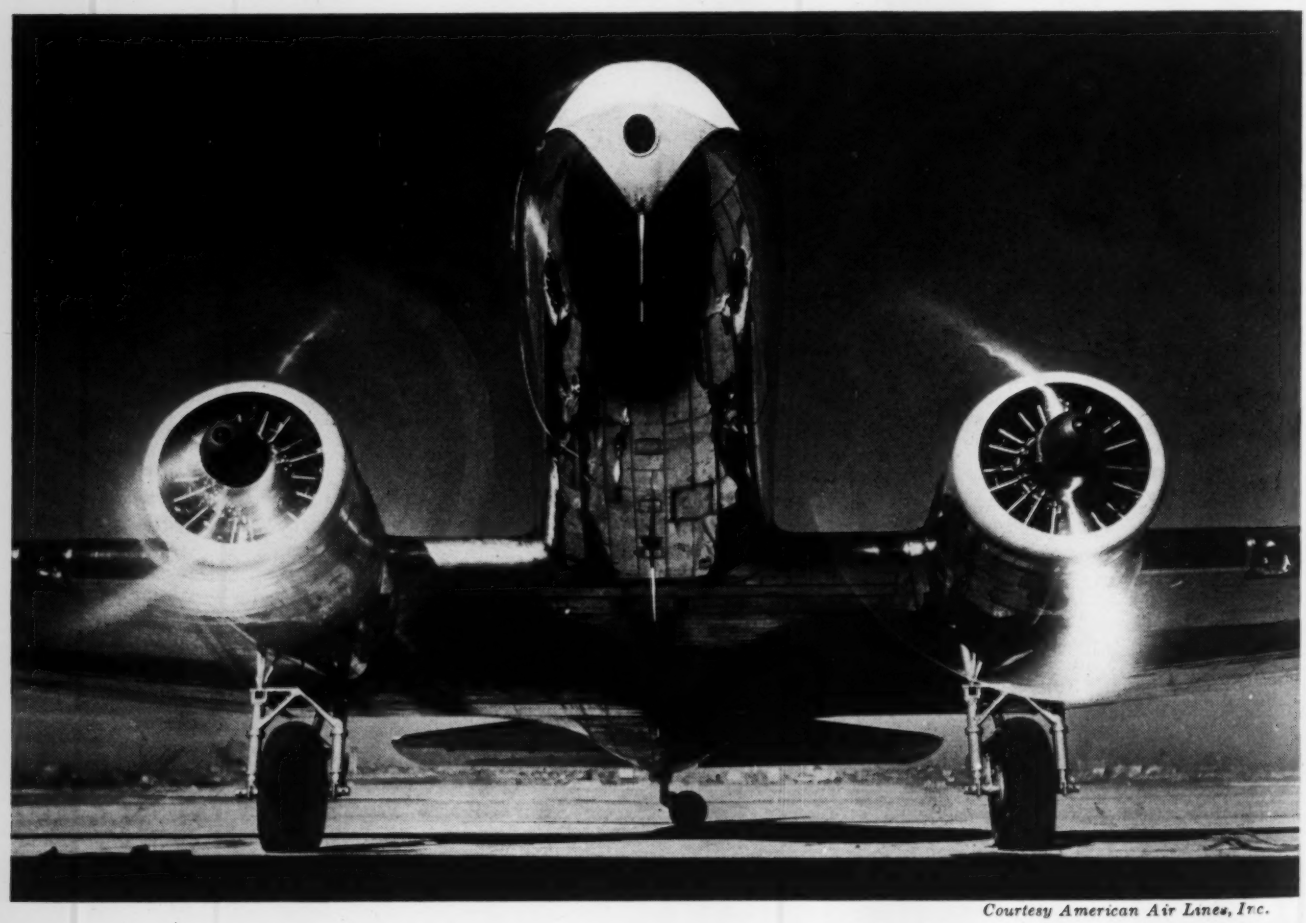
will continue and, while these latter may be sound in isolated cases, the tendency is always for them to attempt predictions of longer range than is warranted by the present state of development of the science.

A step toward bringing the United States in line with other nations in regard to the standardization of meteorological practice has been made by the adoption of a numeral code for the transmission of weather data similar in principle and general structure to the International code. Regrettably, however, the Weather Bureau code is not identical with the International code and, while the differences are small, they represent a lack of the complete uniformity which is the aim of the International Meteorological Organization.

The Weather Bureau has expanded tremendously during the last year the scope of its educational activities, not only by assigning more of its men to the universities for advanced training but also by establishing professional instruction for the Bureau employees in certain centers under the direction of highly trained meteorologists. Temporary assignments of employees to Washington, D. C., and other centers for intensive training are a part of this scheme. Prof. C. G. Rossby, director of the Meteorological Division at the Massachusetts Institute of Technology, has in recent years been the most strenuous advocate of the need for such in-service training and his appointment as assistant chief of the Weather Bureau in charge of research and education must be regarded by those sincerely interested in the development of meteorology with the deepest satisfaction. The raising of the educational level in the Weather Bureau will reflect a beneficial effect on the whole profession. The in-service training within the Bureau is entirely of a professional nature and in a rapidly advancing science will always be necessary in order to keep employees in step with the most recent developments. Nor are the air-line interests forgotten in this training program; in a period of instruction in synoptic analysis held at Newark Airport during the last summer under the direction of Dr. Sverre Petterssen, not only were the Weather Bureau airway servicemen and other employees given instruction but the meteorologists of air-transport companies were invited to attend.

The contributions of the various academic institutions who lay emphasis on meteorological training and research have been considerable during the year, as has also been the research emanating from practicing air-line meteorologists. This latter is encouraging, as there are many problems such as the influences of topography and specific problems of airway terminal forecasting which can only adequately be discussed by meteorologists actually working in the air-transportation field.

The tendency to lift the weather map into the upper air continues. Isentropic analysis is finding more favor, and the radio-meteorograph network enables studies to be made, for instance, of the practical use of the contours of the tropopause. It is reasonably safe to predict that the most striking change within the next few years will be an even greater network of radio-meteorograph stations with, perhaps, more frequent ascents at each. Such developments in general weather forecasting indicate that more and more use will be made of upper-air information and this is directly in the interest of aeronautical meteorology.



Courtesy American Air Lines, Inc.

BELLS—

Concerning Their TONES

By DAVID T. JAMES

MICHIGAN STATE COLLEGE, EAST LANSING, MICH.

BY ALL who have heard a good set of bells, well played, the beauty and charm of carillon music will be acclaimed. Any project, designed to increase further the popular enjoyment of this instrument through attempting to perfect it by eliminating its faults, may then be considered worth while. The author has set himself a problem in the improvement of the carillon.

But first—what is a carillon?

A carillon is a collection of bells attuned to the chromatic scale, weighing from smallest to largest, from 10 lb to 10 tons. Such bells are generally located in the top of a high tower. The tones of the bells are produced by striking them with clappers, manipulated through a keyboard and a set of foot pedals, similar to the arrangement used on an organ. This instrument with which we are dealing is one in which literally tons of bronze produce delicate or stirring melody at will.

Our particular interest in the bells is with their tone and with their tune. The problem is to provide that the principal tone of each bell (for each bell produces a number of tones) is in the proper location in the musical scale of the carillon and to arrange further that various overtones of the bell are in the correct location with respect to the principal tone, and also of a proper volume in relation to it.

For purposes of this paper, the problem may be divided into three main parts: (*a*) For clarification of the musical problem involved, a brief, elementary discussion of music theory; (*b*) an exposition of the present state of knowledge in the science of making bells; (*c*) a section devoted to the theories and experiments of the author.

BASIC MUSIC THEORY

In the beginning of tonal (as distinguished from merely rhythmic) music, a single-line melody alone presented enough difficulties in both production and consumption, for the people of the time, Fig. 1. Then some bright person added an "organum," which was a melody in the same pattern as the original and four scale tones, or in musical terms a fifth, below it, giving a monotonous but pleasant effect, Fig. 2. This was accepted and harmonic theory developed. Gradually, ears accustomed to the perfect fifth (and its inversion, the perfect fourth) grew to accept both the major third and the minor third as consonance (pleasing combinations), Fig. 3.

This was, of course, a slow and painful procedure—almost as painful, we might imagine, as the repeated infliction on the ears of the present generation of the weird tonal combinations, deemed musical by their performers—to the by no means inconceivable end that perhaps even the minor second may eventually be listened to not only without extreme distaste but even with some small degree of aesthetic pleasure, Fig. 4. This process, however, of continually dinning into the ears of the hapless public a chordal combination to which it finally becomes resigned as consonance, is the one which has brought harmony to the point, as we have seen, where the octave, perfect fifth, perfect fourth, major third, and minor third are accepted as consonance. So much for music theory. It will be shown that such small amount of it as has been considered here has some slight connection with the making of bells.

PROCEDURE OF BELLMAKING

Next to be considered is the present state of knowledge in the science of bellmaking. In reality, the exact knowledge of bells is so meager as practically to preclude the use of a word implying such a degree of exactitude as does "science." Bellmaking is still largely an art, depending upon rule-of-thumb methods and the skill of the craftsman. The cross section of a bell is shown in Fig. 5. Rules for the derivation of this shape, as condensed from Grimthorpe (1)[1] are as follows:

Fig. 5 shows proportions for a bell on the 13 scale of thickness, i.e., with the thickness of the sound bow $^1/_{13}$ of the diameter of the mouth. Bells on a thicker scale require a slight modification of the outside curve.

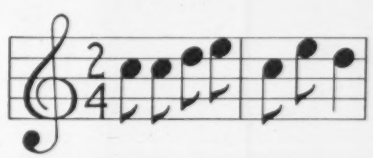


FIG. 1 SINGLE-LINE MELODY

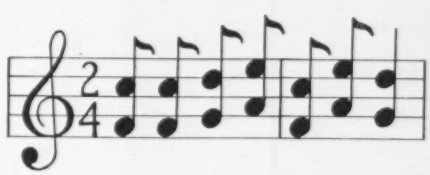



FIG. 2 MUSICAL FIFTH OR ORGANUM

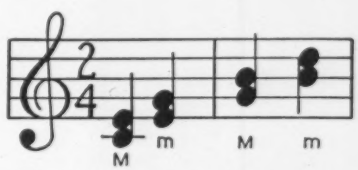


FIG. 3 MAJOR AND MINOR THIRD

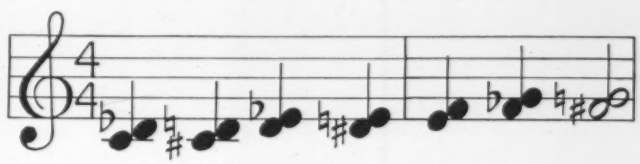


FIG. 4 MINOR SECOND

This paper received The American Society of Mechanical Engineers Undergraduate Student Award for 1939.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

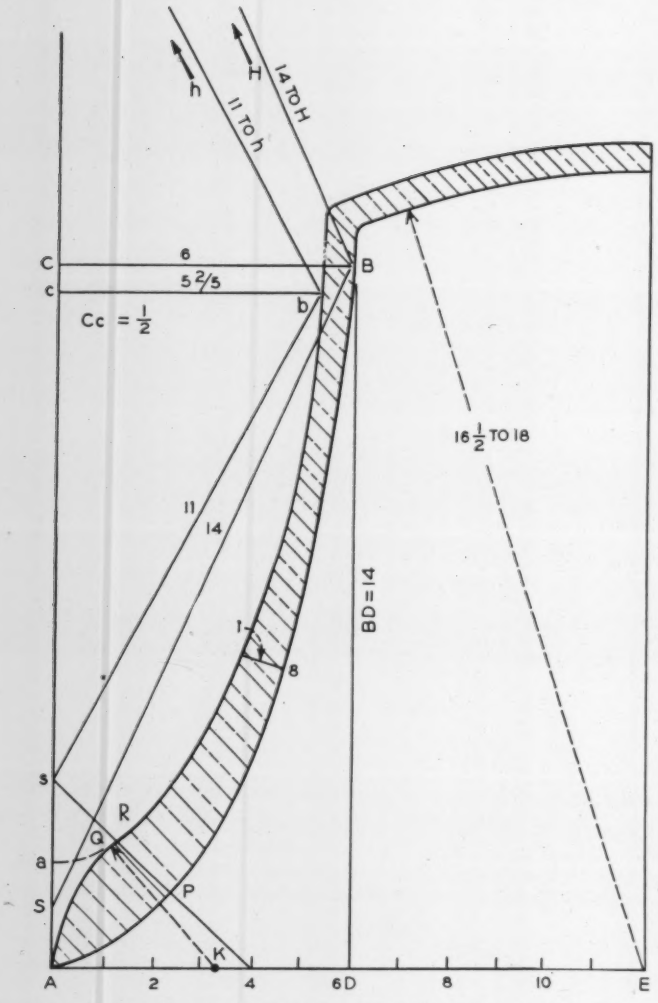


FIG. 5 CROSS SECTION THROUGH TYPICAL BELL

The diameter of the bell at the mouth is divided into 24 equal parts. The inside sweep is a quadrant of an ellipse with the semiaxis major *AC* equal to 14 parts and the semiaxis minor *BC* equal to 6 parts. Mark *B* at 14 parts above *D*. With radius 14 from center *B* mark *S*, and also *H* on line *AC* prolonged. *S* and *H* are foci of the ellipse. Trace elliptic quadrant *AP8B*, the figure 8 indicating a distance on the ellipse of 8 parts from *A*.

The outside curve is compounded of several curves in some empirical way.

$$PQ \text{ (thickness at sound bow)} = \frac{\text{diam}}{13}$$

Thickness at waist = $^1/_3$ sound bow = $^1/_{39}$ diam, or practically $^2/_3$ "part" outside of *B*.

It is necessary to put the minor axis *cb*, $^1/_2$ part below *CB* to make it come right below. From center *b* with radius 11 mark *s* and *h* for foci of another ellipse. Describe quadrant *aRb*, in the same manner as before; draw *sQP*4 to point 4 in the base; mark off *PQ* = $^1/_{13}$ diam; then with radius = $3^1/_2$ or 4 (there results hardly any difference) draw the circular arc *AQ*, letting center *K* come where it happens; fill in *QR* free-hand. Thickness = 1 at 8 from *A*.

The lowest-toned bells are somewhat taller than the elliptic quadrant which forms the inside sweep, and the remainder is added as a cylinder. The top is drawn as a circular arc with the radius equal to from $16^1/_2$ to 18 from *E*, the center of the base; small and thick bells being usually made taller than large ones. The clapper should strike at the thickest part of the sound bow. Very thick bells require the sound bow to be rather higher than in Fig. 5 and, therefore, the lip should project a little more outward or it becomes too lumpy. In that case, curve *AQ* requires drawing with a longer radius than 4.

The greater height of foreign bells, beyond the height of 18 parts, appears a pure waste of metal.

Such were Grimthorpe's recommendations.

It may here be noted that the bell designs of various founders do not follow this pattern closely; as for example, those of the Meneely Bell Company, Troy, N. Y., which are shorter and of considerably greater thickness than the one described. In like manner, the casting procedure to be outlined is subject to considerable variation and innovation.

The mold for a large bell is made in the following manner (2): A hollow perforated iron framework is set up for the core. On it is wound a layer of straw rope. It is then coated with loam which is first stricken off with a sweep to the inside shape of the bell (with a minor allowance being made for tuning, of which more later) and then baked in place. The cope of the mold is made in an iron case in the same way. Then both are coated thoroughly with graphite for smoothness and easy separation of the casting from the mold. They are then put together, care being exercised that they be concentric, and the mold is poured with the mouth of the bell down in order that the best metal may be in the bottom of the bell.

The metal of which the bells are made is a bronze, consisting of 13 parts of copper to 4 of tin (1), or between 20 and 25 per cent tin and the remainder copper, present practice favoring the lower tin percentage (3, 4). The copper is melted first, then the tin is added; when it is thoroughly melted and mixed, the metal is poured into a dried and preheated refractory-lined iron ladle. A handful of powdered charcoal is flung over the surface of the metal at frequent intervals to prevent oxidation. The metal is poured at as low a temperature as is consistent with obtaining a sound casting (1, 2).

TUNING THE BELL

Now provided a sound casting has been obtained, we are prepared, after cleaning the casting to tune the bell, should it need it, and at present this is almost invariably the case. The bell emits, as has been said, a number of tones and, in this connection, the analogy of a string may prove helpful. A string, such as that of a piano, vibrates in more than one manner. First, it vibrates as a whole, emitting its fundamental tone, Fig. 6. In this case *C* below middle *C* of the piano, or *c*.

At the same time, it vibrates in halves, emitting an octave to the fundamental, Fig. 7, this tone having twice the vibration rate of the first, and being of a less amplitude of vibration, with the consequent less amplitude of sound.

Likewise it vibrates in thirds, Fig. 8, producing the perfect fifth to this octave, or the thirteenth to the fundamental.

And so on up, the string vibrates simultaneously in quarters, fifths, sixths, sevenths, and others, to some limit defined by its flexibility, and produces the series of natural harmonics of which on this musical staff a small part is shown, Fig. 9. Of course, each of these tones, since it is produced by a smaller segment with necessarily less amplitude of vibration, is less pronounced, until the higher tones are inaudible. This is the case with strings having low fundamental tone, due to their small magnitude. Other strings with high fundamentals, be the vibrations of any magnitude whatsoever, are too high in rate for the audible range. All these pitches are rigidly defined by the natural division of the string. Bells, too, emit a characteristic series of overtones. However, the overtones in bells may be out of tune with the fundamental, as contrasted with those of a string. This is the case, because the tones in a bell are produced in horizontal zones (5), each zone producing its

own tone and taking no apparent part in the production of any other tone.

PROCEDURE FOR TUNING BELLS

A bell vibrates essentially as a stack of rings, each ring vibrating in the following manner: When struck (from the

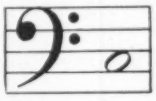


FIG. 6 FUNDAMENTAL TONE
(c = 132 vibrations per sec.)

FIG. 7 OCTAVE TO FUNDAMENTAL TONE
(c' = 264 vibrations per sec.)

FIG. 8 PERFECT FIFTH TO OCTAVE
(g' = 396 vibrations per sec.)

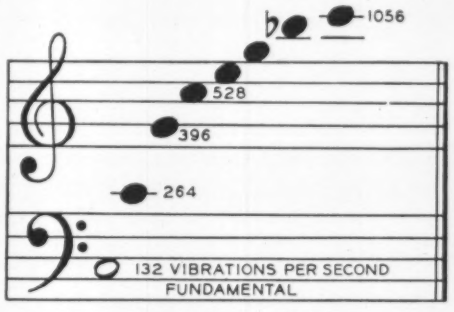


FIG. 9 NATURAL HARMONIC SERIES

inside), the ring is elongated into an ellipse with its major axis along the line of travel of the clapper, Fig. 10. The natural elasticity of the metal draws the ring back to its original shape when, due to its inertia, the material travels beyond to flatten the ring into an ellipse with its major axis perpendicular to the line of flight of the clapper. This leaves 4 nodes *N* of no vibration, and 4 antinodes *A* having the most extreme vibration. Elasticity, of course, repeats this performance until the material, being not perfectly elastic, damps out all the supplied energy and comes to rest. Some rings in larger bells vibrate in a more complicated fashion, having 6 or 8 nodes. For purposes of this discussion, it is to be understood that each horizontal section of a bell has its own rather distinct function. Each alone produces a tone.

The proper tones for a bell are those indicated in Fig. 11, as determined by the best musical authority, although there is some discussion at present concerning their correctness. The most prominent tone of a bell, and that after which the bell is named, is the "strike" tone. One octave below is the "hum tone;" one octave above, the "nominal;" a minor third above, the "tierce;" a perfect fifth above, the "quint;" and in better bells, the major third above the nominal and the perfect fifth above the nominal are also present and in tune. Removal of metal from the inside of the bell lowers its pitch, and removal of metal from the lip of the bell raises the pitch but with the attendant danger, in the latter case, of throwing the overtones out of balance which, in general, precludes its use. The tuning process in condensed form, Fig. 12, according to Canon Simpson (6) is as follows:

1 *Nominal Tone.* (*a*) To sharpen, removal of metal from triangular portion *HDE* may sharpen the nominal as much as $^1/_8$ tone. (*b*) To flatten, removal of metal from *H* to *C*, or as far as *B*, if necessary, will flat the nominal as much as $^1/_2$ tone if desired.

2 *Fundamental Tone.* (*a*) To sharpen, remove metal along *CD*, which is a safe process until line *C-E* is reached. (*b*) To flatten (according to foreign experts), remove metal from *C* to *G* or to *B*, if necessary.

In addition, as derived in conjunction with the foregoing:

1 The fundamental cannot be flattened without also flattening to some extent, the nominal.

2 The nominal can be flattened considerably without altering the fundamental, viz., by taking off metal on both sides of *C*.

3 The nominal can be flattened slightly, while, by the same

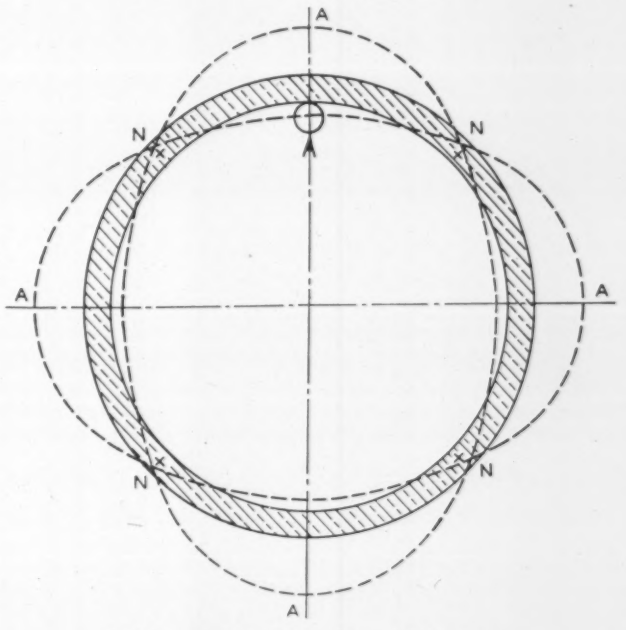


FIG. 10 DIAGRAM SHOWING BELL VIBRATION

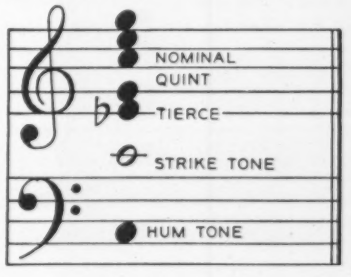


FIG. 11 DESIGNATION OF BELL TONES

process, the fundamental will be somewhat sharpened, thus bringing the two toward each other, viz., by reducing the rounded surface *CE* to a flat surface.

4 The fundamental can be sharpened considerably while leaving the nominal nearly, if not quite, unaltered.

5 Although the process of sharpening the nominal will also raise the fundamental, it will not do so in the same degree, and will therefore tend to bring the two together in the unusual (and very objectionable) case of the fundamental being originally the sharper tone.

Canon Simpson goes on to say that, by following this pro-

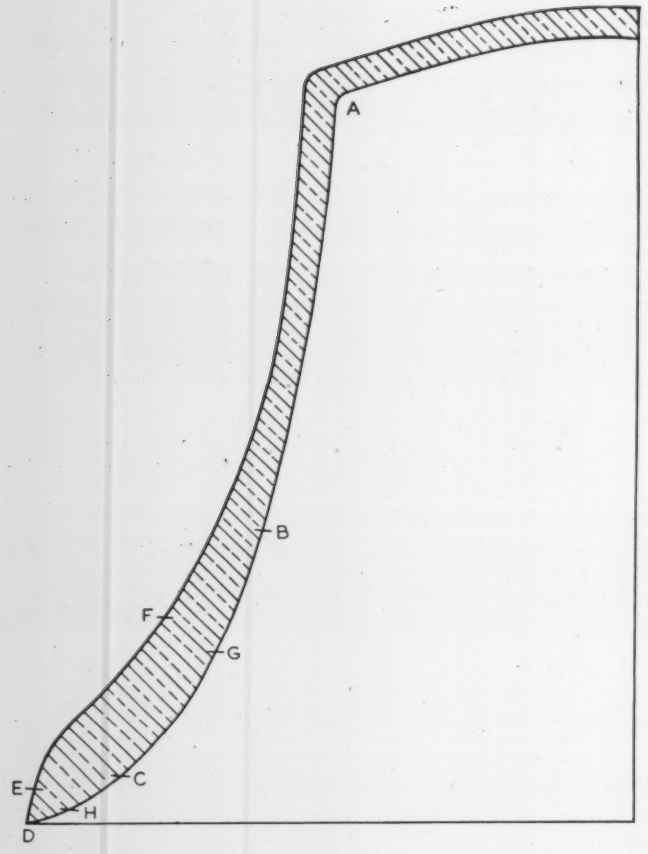


FIG. 12 GUIDE FOR TUNING PROCESS

cedure, it is evident each bell can be put in tune with itself as regards the fundamental and nominal tones and, further, since this is so, they may be cast in tune in the first instance.

PROBLEM OF CASTING BELLS IN TUNE

In spite of this theory, the founders have not in the course of years learned to cast bells to just the proper tone and combination of overtones. Some have developed the process of removing metal for tuning to a finer degree than that indicated by Canon Simpson, but often with the sad result of weakening, while bringing into tune, certain of the tones. One American firm, the Meneely Bell Company, carries a large stock of bells which are matched for tone, overtone, and "personality." In this way good results are achieved and machining processes avoided, but at the expense of a high overhead in interest charges on capital tied up in stock. Furthermore, it is necessary at times to go to the slight trouble of "brushing" a bell into tune, that is, removing a trifle of the metal with a portable grinder.

It seems therefore that, if any way can be devised to cast bells to the exact proportions which would assure their being harmoniously in tune, a great saving in time for tuning (which is rather thoroughly an art), or in interest charges on a large stock or in dissatisfaction with poorly tuned bells may be made. Therefore, the first purpose of an investigation for the improvement of bells would appear most logically to be not the determination of the faults of present bells but the determination of just what should be the exact proportions of a bell to produce a given strike tone and to produce overtones harmoniously in tune with and properly in proportion to it.

To the best of the author's knowledge, all investigations of bells to date have had to do for the most part with bells in existence before the start of the investigation, as for example those of A. T. Jones on the bells of the Dorothea Carlisle Chimes at Smith College (5). These investigations bring up many matters of interest, as for instance, the absence, in any tangible form, on the bell, of the vibrations to produce the strike tone, supposedly the most prominently heard tone of the bell. Such investigations may serve a useful purpose. In fact, the author has devised an apparatus for the investigation of existing bells, Fig. 13. Nevertheless, it is the author's belief that an investigation made on new materials, under the control and supervision of the investigator and from a different viewpoint than the previous historical one, may yield more useful and usable results.

EXPERIMENTAL STUDY OF BELL ELEMENTS

The following is an account of an experiment carried out at Michigan State College in the spring of 1939 to furnish experimental data for a mathematical solution of the proper shape of bells. The basic assumptions for the experimental work were:

1 That a bell may be considered as a laminated heap of rings, each vibrating in its own particular mode as a ring, but subject to certain modifications of its mode, due to its close association with the rings on either side of it. The various tones emanating from the bell are therefore dependent upon the vibration rates of the assumed rings, modified by certain constants or mathematical functions. On this assumption, the hope was founded that experimental results might lead to a formula integrable over the height of a bell (containing the characteristics of tone, tune, and volume desirable in bells), to reduce the form and various thicknesses of a bell to a point where they at least approach mathematical certainty.

2 That the vibration rate of a ring in the horizontal plane depends upon the diameter and upon the horizontal thickness of the ring; the variation of vibration rate, with variation in thickness or in diameter or in both, in all probability following no simple mathematical law, due to the inherent tendency of castings to have no regularity of characteristic in the metal from extreme outside to inside of section.

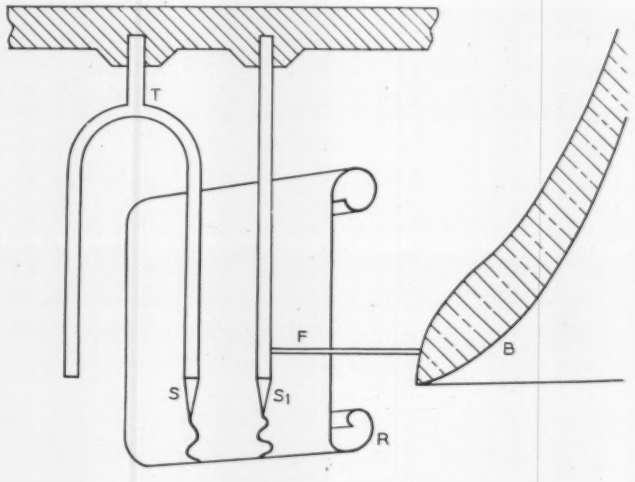


FIG. 13 VIBRATION COMPARATOR

Simultaneously:

(*a*) Strike bell *B*.
(*b*) Strike tuning fork *T*.
(*c*) Start recording tape *R* moving beneath recording points *S* and S_1.

Vibration of bell is transmitted through feeling rod *F* to stylus S_1 to be recorded on sensitive tape.

At the same time the standard vibration of the tuning fork is recorded through stylus *S* next to the trace, recorded from the bell.

Vibrations in various parts of the bell may be compared through the standard vibration of the fork.

3 That a ring of comparatively small height has no overtones of its own vibrating in the horizontal plane.

4 That uniformity of metal must be maintained for uniformity of experimental result, the metal in this case to be 4 parts tin and 13 parts copper by weight.

With these assumptions, the following procedure was carried out:

1 Patterns were made, measured with a bronze shrink rule, having the purpose in mind of producing bronze rings in two series, one series to have constant diameter and varying horizontal thickness, the other series to have constant horizontal thickness and varying diameter, and all rings to have the same height.

2 With these patterns, ring molds were made in green brass-molding sand, each having a diametrically opposed sprue and riser.

3 New metal was formed in the case of three rings, two rings being entirely of new metal and a third containing sprues, risers, and excess from the other two. The metal was melted in an induction furnace, copper from electric cables being melted and Straits tin added in the proper proportions, the resultant alloy being poured at as low a temperature as was deemed probable to give a good casting.

Two rings were recast from remelted metal from two of the first set and a certain amount of new metal; this was done on the assurance of an experienced metallurgist that the composition change due to remelt would be so small as to be insignificant, as compared with probable errors in weighing for the original rings.

4 The castings were cleaned by sandblasting. Risers and sprues were sawed off the castings. Fins and other unplanned projections were ground off. It was attempted, however, to leave the casting as nearly as possible in the as-cast condition, for it was borne in mind that the best qualities of bells are possessed only by those having practically no machining processes carried out on the finished casting.

5 Rings found to contain too-serious flaws were recast. Minor flaws, such as slightly pitted and washed surfaces, while deemed undesirable, did not constitute a sufficient reason for discard of the rings. Two rings with deep draws were accepted, due to exigencies of time and in view of the fact that their tone was very much alive and gave no harsh discord or rapid "beat." All rings were suspended from a resilient mounting and struck to determine qualitatively the trueness of tone.

6 Each ring was suspended by linen thread on a ring stand. A variable electrical vibration was set up in an electrical oscillatory apparatus to produce a tone from a loudspeaker for comparison. The lowest audible tone of each ring was taken as its fundamental (for each emitted several tones, these being largely due to vibration in other planes than that of the flat surface of the ring). The tone of the loudspeaker was adjusted as closely as possible to that of the ring down to the point of about 1 beat per sec and (due to necessary interpolation on charts supplied with the electrical apparatus) a possible range of 5 vibrations per sec was allowed for the determination of the vibration rate of the ring.

The results of the investigation are given in Table 1, and plotted in Figs. 14 and 15. Conclusions to be drawn from these data are few and speculations many.

1 It may safely be concluded that, with increasing thickness, the vibration rate of a ring increases and, with increasing diameter, it decreases.

2 It is concluded that a large number of experiments on a greater number of less dispersed variations would, in all probability, give a curve from which it would be possible to obtain a mathematical result. This would, of course, require the expenditure of a great deal of time, money, and painstaking effort, but the author believes that the research would prove profitable in tuning time saved and even in the necessity for any tuning.

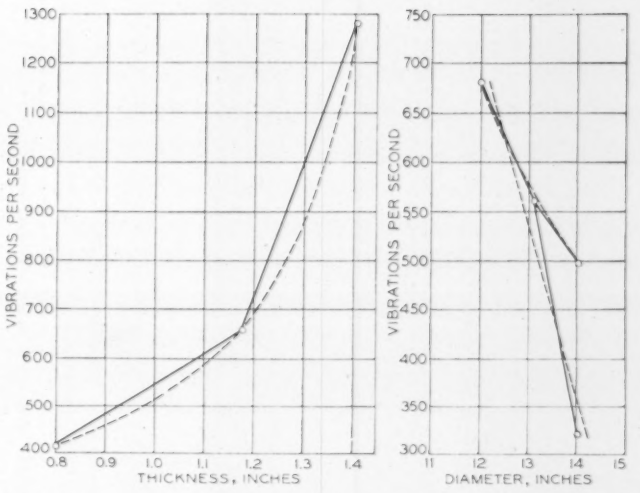


FIG. 14 VARIATION IN TONE OF 12-IN-DIAM BRONZE RINGS WITH VARIATION IN THICKNESS

FIG. 15 VARIATION IN TONE OF BRONZE RINGS 1.2 IN. IN THICKNESS WITH VARIATION IN DIAMETER

Speculations are indefinite at best and are not here included except as indicated by the variety of possible lines on the graphs.

3 Further, it is deemed best that, upon further experiment, the pouring temperature of the metal be kept within very closely defined limits, as it affects the density of the resultant metal.

TABLE 1 EXPERIMENTAL DATA

Proposed dimensions

Specimen no.	Height, in.	Thickness, in.	Outside diam, in.	Volume, cu in.	Weight, lb
2	3/4	1.2	14	36.3	11.42
3	3/4	1.2	13	33.4	10.55
4	3/4	1.2	12	30.6	9.64
5	3/4	1.4	12	35.2	11.10
7	3/4	0.8	12	21.2	6.68

Actual dimensions (avg)

Specimen no.	Height, in.	Thickness, in.	Outside diam, in.	Weight, lb	Vib. per sec ± 2.5
2	3/4	1.187	14.065	12.00	500 or (321)[a]
3	3/4	1.213	13.127	11.00	563
4	3/4	1.179	12.046	9.81	682.6
5	3/4	1.429	12.108	11.44	1278.5
7	3/4	0.798	12.087	6.75	415.3

[a] 321, a very faint tone, possibly the fundamental; a ring between Nos. 2 and 3, as respects diameter, would probably give an indication of the correctness of either 321 or 500 as the fundamental vibration.

BIBLIOGRAPHY

1 "Clocks, Watches, and Bells," by E. B. Grimthorpe, revised edition, Crosby Lockwood and Co., London, 1883, pp. 335–391.

2 "Appleton Cyclopaedia of Applied Mechanics," revised edition, vol. 1, D. Appleton-Century Company, New York, N. Y., 1904, pp. 117–119.

3 "Bells," *Fortune*, vol. 17, January, 1938, p. 10.

4 "Cast Bronze Bells in Mexico," by H. H. Miller, *The Foundry*, vol. 67, February, 1939, pp. 30–31, 82.

5 "The Tones From Bells," by A. T. Jones, *Physical Review*, vol. 16, October, 1920, pp. 247–259.

6 "On Bell Tones," by Rev. A. B. Simpson, *The Pall Mall Magazine*, London, vol. 7, 1895, p. 183; vol. 10, 1896, p. 150.

WAR *on* WEIGHT

By JAMES L. WALSH

NEW YORK, N. Y.

SLIGHTLY more than a pound per horsepower, the War Department announced recently as the weight of an aircraft engine of completely new design which had just passed successfully the Army Air Corps tests at Wright Field, Dayton, Ohio. Liberty aircraft engines of World War days weighed about $2^1/_2$ lb per hp. Twenty years of patient research has cut this in half, for the new engine actually weighs approximately $1^1/_4$ lb per hp.

To the military aviator, striving to keep America out of war—and even more important, to keep war out of America—decreased weight per horsepower means increased speed for pursuit planes, increased bomb-carrying capacity for bombers, increased radius of action for observation planes, or some more advantageous combination of speed, range, and attacking power. To the fighting airman it may mean his life.

War brings fundamentals into high relief. When the stake is high engineers cannot afford the luxury of unnecessary weight. Accurately adequate strength is the goal. The acid test of any weapon is what it delivers in offensive power per pound of weight. Wars of the future are being won or lost on the drafting boards of the ordnance engineers of today, who seek to win a war by waging unceasing war on weight.

During the World War, the average operating speed of a tank was not much in excess of 4 mph. After the Armistice, a board of officers of the United States Army examined every tank design in every army. As a result they somewhat hesitantly urged that a speed of at least 10 mph should be sought after by ordnance engineers. Now, due to the elimination of needless weight, a speed of 50 mph has been attained.

Due to increased mobility, a single tank can now cover five times as much territory as was thought possible at the end of the World War; it requires only one fifth of the time to break through an opposing barrage. If necessary to move it away from the enemy, the higher speed due to elimination of needless weight might well mean the difference between escape and destruction—the difference between having a tank available or no tank at all.

Engineers think clearly and accurately when the stake is high.

The driving force of military necessity begets the idea and peacetime generations which follow enjoy the benefits in ever-increasing measure.

Unnecessary weight is costly wherever it is found. It has been eliminated with profit in the design and manufacture of such widely diversified articles as artillery and vacuum cleaners; airplanes and celery crates; streamlined trains and cooking utensils; military tanks and orange boxes; automobiles and bridges to carry them; skyscrapers and trailers; freight cars and airplane propellers; high-tension electric-transmission cables; and high-speed passenger elevators.

No extraordinary engineering genius is required to design a building, a machine, or a box that is strong enough to serve the purpose if one is not concerned with how much stronger than strong enough it is. However, real engineering skill is required to make a building, or a machine or a box safely strong, but no more than that. Accurately adequate strength is the prime objective today, with the emphasis on the word "accurately."

Needless weight is needless waste. It means unnecessarily high cost of manufacture or construction, and unjustifiably high cost of transportation or operation every time needless weight is moved. The law of gravity never sleeps and cannot be repealed.

Not so long ago, weight and strength were practically synonymous terms in appraising relative values. Many an article was judged solely by its "heft." If it was light, it was considered flimsy, and therefore unsatisfactory or at least inferior. If it was heavy, it was often by that fact alone adjudged strong, and therefore satisfactory, or, in any case, superior to its lighter competitor. But the invention and development of the airplane changed all that because airplanes and every part that went into them had to be made light as well as strong or the airplane would never leave the ground. Here, accurately adequate strength was prerequisite to the birth of a new industry.

Even "lightweight lacquer" as a "one-coat" finish for all metal surfaces of aircraft has been developed by weight-saving-minded engineers and is now under test by aircraft manufacturers, as well as Army and Navy authorities. Forty pounds was set by an aircraft manufacturer as the weight allowance for paint beyond which he could not go and compete successfully. After two years of research the lacquer manufacturers devised a complete coating which weighs only 15 lb. The result is 5 mph higher speed, in addition to easier maintenance, better surface protection, increased visibility in time of peace, and more effective camouflaging in time of war.

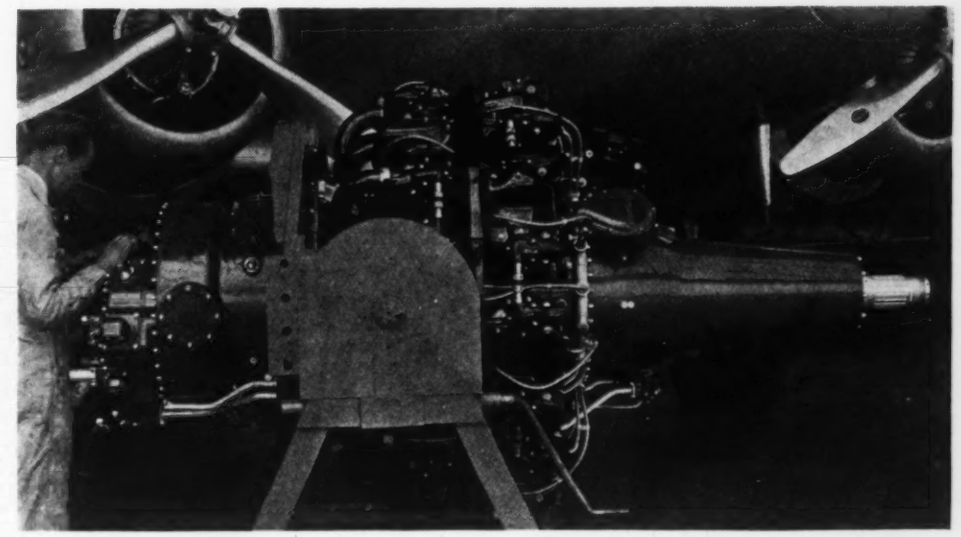
A few years ago, under the leadership of a former Army Ordnance officer, Col. E. J. W. Ragsdale, the railroad-transportation industry seriously considered how to save weight in the design and manufacture of passenger cars, freight cars, and motive power. According to J. J. Pelley, president, Association of American Railroads, in an address before the American Institute of Mining and Metallurgical Engineers, "the Association is now testing a boxcar in which weight is reduced to a still greater extent. In fact, the car now being tested weighs approximately six or seven tons less than practically all of the boxcars of like capacity in service today."

A fairly accurate estimate of what weight saving means to the railroads is available in the statements of Ralph Budd, president, Chicago, Burlington & Quincy Railroad, who pointed out in 1935 that:

> There is no doubt about the importance of having the cars as light as possible, because in any case the lighter the cars, the greater the percentage of the gross load behind the locomotive that will be "pay" load. . . . With lighter equipment there would be less ton-miles over the rails. That would make a difference in the wear and tear on track, as we have observed less ton-miles have done during the depression. The possibilities of lighter-weight equipment are intriguing. In 1934 approximately 400 billion ton-miles were made, in handling freight and passenger cars, exclusive of the loads they carried. If, as is quite possible, these cars should be reduced one fourth in weight, it would require 100 billion less ton-miles to handle the business. At one mill per ton-mile that is 100 million dollars a year.

Here accurately adequate strength holds out hope to an industry engaged in a struggle for survival. Elimination of needless dead weight in and by the automobile industry put it in position to challenge, and substantially to capture, business hitherto the sacred preserve of the railroad industry. Perhaps the same advanced engineering thinking will help the railroads restore the economic balance.

One hundred million dollars per year is the tribute which needless weight in railroad cars exacts from the railroads, from the shippers, and ultimately from the ultimate consumer. That one hundred million dollar saving assumes handling the same amount of business in the same number of cars—only



18-CYLINDER AIRCRAFT ENGINE WEIGHS APPROXIMATELY $1^1/_4$ LB PER HP AT SEA LEVEL AND ONLY ABOUT $1^1/_2$ LB PER HP DELIVERED ABOVE 20,000 FT

each car has had needless dead weight eliminated, so that it weighs one fourth less than the old equipment. This does not take into account possible additional savings due to elimination of needless dead weight in packages, to more compact stowage, and to those due to reduction in loss and damage claims.

Investigation along these lines had not yet proceeded to the point where an over-all picture of possibilities can be presented. However, in moving one particular commodity, it was computed that scientific packaging and stowing would enable four freight cars to do the work of five under the present system of packaging and stowing. Twenty per cent less equipment is required to handle the same "pay load," and incidentally a very substantial reduction in loss and damage claims is indicated.

When the weight-saving engineer attacks a problem, he often develops collateral benefits which in some cases are fully as important as the attainment of his original objective. A lightweight passenger train may well prove to be not only less expensive to operate, but smoother riding and generally more attractive to a degree which results in additional patronage. Thus not only is dead weight decreased, but actual pay load behind the locomotive is increased. Or a train of lightweight refrigerator cars, weighing 44,000 lb each, as compared with the usual 56,000 lb each, yields not only lower operating costs but faster speeds, and the resultant shorter time in transit means less icing and correspondingly lower icing costs and more revenue trips per year.

In the case of a large machine which included a conveyer composed of large links of heavy metal, the original complaint was that it used too much power. In seeking to reduce the weight of moving parts, a lighter, stronger metal was used with the result that breakage of heavy links, which had been frequent, ceased entirely. Redesign accomplished not only weight saving and power saving, but also savings in cost of replacing links and savings in labor and overhead due to "down time."

A manufacturer, who used large quantities of a certain material, felt that the shipping boxes were much too strong and heavy; and hence were costing him too much in freight. The primary attack was successful in saving freight charges of $54,000 per year. These boxes, containing from 500 to 800 lb, were lifted from freight cars by a traveling crane and stacked in tiers to a height of about 30 ft. Details were not made available, but the manufacturer made the statement that savings, which were effected due to the lighter packages, were almost as much in crane-handling costs for vertical transportation, as the savings in freight charges for horizontal transportation.

When a package is too weak and fails to transport merchandise safely from the producer to the wholesaler, to the jobber, to the retailer, and to the ultimate consumer, that fact is so obvious that all concerned have an immediate financial interest in correcting conditions by strengthening the container. On the other hand, if it is too strong, it is undoubtedly too heavy. If it is too heavy, unnecessary freight charges and other handling charges have been levied against the contents all the way along the line from the time the container was first purchased until the consumer opens it to remove the contents. Other things being equal, the heavier the container the higher the first cost, and also the higher the cost of assembly, packing, and preparing for shipment.

Efforts to reduce freight charges through decreasing tare weight rest on a sound economic foundation. If freight charges for transporting a given article from its place of manufacture to its place of use can be reduced, the sound economic thing to do is to pass along the saving in great part to the ultimate consumer. The consumer benefits because he gets more for his dollar. The producer benefits because his profit is the same, but selling price (including freight charges) is reduced—and decreased selling prices mean broader markets. All the service agencies, railroads, warehousemen, insurance companies, and forwarders benefit through the greater flow of goods through the channels which they provide for moving goods from producer to consumer.

Transportation costs are based largely on weight and distance. We cannot change geography but we can change weight by pruning every "parasite pound." And it's being done. In New York City the average driver of a milk wagon lifts 25,000 pounds of glass bottles, milk, and wooden carrying trays per week. A revolutionary change in container design cuts his burden to 10,000 pounds per week. Yet the prices paid to dairy farmers are the same; earnings of milk-wagon drivers are increased; and the householder pays for his *milk* $1^1/_2$ *cents less per quart*.

This is not an isolated instance of the benefits which flow from the elimination of needless weight. Similar instances could be cited in many fields of activity, but there is plenty of ground still to be taken. There is plenty of opportunity for the engineers of America to enlist in the "War on Weight."

ENGINEERING-SOCIETY LIFE *of the* YOUNG ENGINEER

By A. G. CHRISTIE

PAST-PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

EVERY young engineer should become a member of one of the large national engineering societies, preferably at once, or as soon as possible after graduation from college. Technical and social benefits both direct and indirect may be derived from such association. A yet more important consideration is that, through these national societies, the newcomer to professional work can aid in maintaining and extending the status of engineering as a profession.

STUDENT SECTIONS

Actually, the young engineer's interest in his engineering society should begin during his student days. But he will ask at that time: "Why join this society? What is gained by doing so?" Student sections of the various national societies have been established in most engineering colleges. Students join these sections either under the urge of their fellow students, or with the definite idea of early association with the national society of their chosen branch of engineering. Few really appreciate fully the gains which may accrue from active participation in a student section. Those who have served as honorary chairmen of student sections or have otherwise directed their activities appreciate the difficulties encountered in making effective the work of the section.

Consider in the first place the advantages which a student may gain from participation in section activities. Unusual opportunities are offered to those who become officers in such sections. Initiative is developed in carrying on the work of the section; enthusiasm is created for promoting interest in the section by inducing fellow students to join; the qualities of leadership are fostered by directing the work of the various committees and of individual members. Section officers must learn parliamentary procedure, methods of keeping accounts, the effective presentation of reports, and certain publicity methods to assure good attendance. All of these experiences contribute to a man's growth as an executive, and have a commercial value in later life.

The student member should be encouraged and in fact expected to prepare papers and discussions for presentation at section meetings. These are more effective if they relate to actual experiences of the student. In this connection, summer employment offers subjects of general interest to fellow students who are eager to learn what is encountered in actual engineering practice. Such presentations lead to earnest discussions, as others wish to learn more of the details than the speaker at first indicates. The author recalls among others two such talks by students which were of great interest to their fellows. One related to can-making procedure and can-making machinery, as observed during a summer job. The second student discussed the operations of a canning plant and the methods of filling, sealing, sterilizing, and packing canned goods. Every college class contains individuals who have had industrial experiences which, with lucid presentation, would arouse the interest of fellow students and in many cases increase their respect for the one presenting the discussion. For instance, a student, who had worked as a toolmaker, had assisted in the development of a special knotter to join threads in a weaving machine. Details of the device and its production aroused unusual admiration among his classmates.

The idea of presenting personal accomplishments and observations deserves particular emphasis, for one of the prime functions of a learned society is to provide an opportunity for its members to exchange experiences to their mutual advantage. There is the further consideration that one learns to appreciate an associate in proportion to his accomplishments in technical development. Such an address as outlined thus offers a proper and dignified channel for a student to inform fellow members of his individual work and of its relative importance.

Another stimulus to interest is the presentation of results of researches by graduate students or faculty members in advance of publication elsewhere. This induces pride of the student in the achievements of his college and in many cases arouses in him a desire to carry out similar projects himself. The presentation of such new ideas stimulates his creative instincts and may lead to useful developments and inventions.

Addresses by members of the staff, by officers of the national society, and by practicing engineers may be of special value if these are carefully prepared and ably presented. Students have a keen desire to know what an engineer does. Personal experiences and developments are always welcomed as subjects for discussion. Such addresses do much to enhance the profession in the minds of students.

Abstracts of papers presented at national meetings also constitute excellent subjects for student meetings. If there is active discussion, this may be of interest and value. Too often the student members consider that the speaker does not know his subject thoroughly and that they are hearing of things "secondhand."

Student members are generally invited to all local-section meetings. These occasions afford an opportunity to meet and become acquainted with older members. Wide contacts have a definite commercial value in later professional life.

In summary, membership in student branches of the national societies is most desirable. It affords an opportunity for self-development both in organization and in public speaking. Pride in the profession is developed through contacts with older members, society officials, and staff. The student, through his reading of the publications which he receives, has his technical interest stimulated by articles on professional subjects prepared by outstanding authorities. Discussions held by the student section itself are invaluable in promoting initiative and enthusiasm.

UPON GRADUATION

Most individuals in engineering colleges belong to student sections. Upon graduation the embryo engineer often severs his connection with his professional society. He does this for several reasons. He may find that he does not have the funds available for increased annual dues or he prefers to spend

Address presented before the Association of Land Grant Colleges, Washington, D. C., November 15, 1939.

his money in another manner. He may be located where there is no local section of his professional society and sees no advantage in continued long-distance membership. He may for the moment have employment that has little relation to engineering and his professional interest lags. Then he may have a job in a different branch of engineering from that pursued at college and is unable to decide which branch will constitute his life work. There are also cases where the graduate is employed by a large corporation which subscribes to the society's publications and circulates these among its staff. He reasons that he is getting the cream of the society's products and does not see what he would gain further by holding membership and paying dues. In other words, as a professional man, he fails to appreciate the value of association with his fellows or of sharing in their group activities in the national society.

Young men at this stage often do not understand that they are under the critical scrutiny of their superiors and are being appraised for engineering work. An evident ambition to succeed, a keen interest in their professional society, and a desire to meet and associate with older engineers and to share in their interests, are factors which lead to early selection for promotion. Many a young engineer who has shown none of these interests is unable to understand later why he has not been advanced as rapidly as some of his associates. Such laggards become the routine men in industry—seldom developing leadership.

Why should a graduate immediately join his professional society after leaving college? In the first place, he will become associated with older engineers who are devoting time and effort to elevate the profession of engineering and who are thereby endeavoring to secure for it that status in society which will command honorable respect and ample remuneration for services rendered. Such association gives the young engineer a justifiable pride in his chosen profession and encourages him to put forth his best efforts in those early years after leaving college. The value of extended acquaintance cannot be overemphasized. An engineer's friends are among his greatest assets in later life as they often recommend him for advancement or for new jobs.

Some young engineers hold that they do not get their money's worth from membership in a society. This "money's worth" is judged unjustly if one figures only the sales price of monthly journals or annual transactions. Committee work costs money and these funds come from society income. Such committees develop standards of manufacture, standard procedure, test codes, codes for construction and operation, safety codes, international standards, patent procedure, etc. Such products of committee effort are difficult to evaluate in money yet have a profound and far-reaching effect in promoting safety and sanitation, lessening injuries, and thus enhancing the reputation of the engineer and promoting the economy and well-being of the entire nation. They form a portion of the engineer's contribution as a professional man to industry and to society as a whole.

Other committees promote research projects, the results of which accrue to all. Still other committees and organizations, such as the American Engineering Council, are concerned with the economic status of the engineer, with his place in national affairs, and with the engineering aspects of government.

Finally, certain society monies are devoted to prizes and awards to encourage initiative and resourcefulness in student, junior, and senior members of the society, and these have far-reaching value in the development of new methods and products.

The dues of a member, therefore, represent an investment not only in published matter but in means for promoting both the national welfare and honor and respect for the engineering profession.

JUNIOR MEMBERS

The period of several years, which elapses between graduation and the time when a graduate attains the full status of an engineer, presents many problems. His experience indicates that many engineering practices do not follow strictly the mathematical laws familiarized in college. He must acquire an understanding of how to turn his personal experiences and those of others to useful account. He also must discover that it is essential to develop his technical knowledge beyond that acquired in college. In the solution of these problems he naturally turns to his technical society for help and guidance.

The complaint is sometimes heard from a junior member of a society that he finds no way in which he can participate in its activities. He feels that all committee appointments go to the older members and that these seniors take a too-conservative view on all questions.

In certain of the societies, the proportion of junior members is steadily increasing and has become a comparatively large percentage of the entire group. Obviously, these younger men should share in the functions and activities of the society. In some societies, junior groups have been formed in the local sections and are being enthusiastically supported. Junior members are being added to main committees. It should be one of the functions of the junior-group movement to train its men for work on the society's committees. In this connection some difficulties arise. Many junior members cannot afford the time or the money for committee participation. The income of the society does not permit it to pay the expenses of such men. It would, therefore, appear best to turn over a large part of the control and operation of the local sections to the juniors. This does not require the sacrifices in time and expense, involved by the main national committees, in journeying to distant meeting points.

Through their publications the national societies also provide means for presenting the accomplishments of younger men in research or development to the profession as a whole. An outstanding paper by a young engineer, which has been accepted for presentation before a national society, leads to his recognition by others which may take the form of promotion in his own company or of offers of lucrative jobs elsewhere.

Young engineers sometimes claim that the national societies take no particular interest in the economic status of the engineer. They therefore listen to those who advocate trade-union forms of organization for engineers. The difficulty with union affiliation is that the young engineer must assume an antagonistic attitude toward the administration of his concern. This attitude is a distinct handicap to selection for executive positions where he must promulgate the policies of his organization. The problem of proper remuneration for engineers is a difficult one. Attempts have been made to fix salary scales, but these have not been universally accepted. Economic conditions and competition for jobs in various sections of the country are disturbing factors. Finally, depressions tend to upset established rates, as cuts in salary are common at such times. It is a fact that the average pay of the young engineer when starting his industrial career is low in comparison to trained mechanics and laborers. This condition needs consideration and correction.

Clearly, our national societies must give more thought to this question of remuneration for the members of its professional group. Otherwise, some labor-union organization will preempt this function to the detriment of the national society and of engineers themselves.

The increasing importance of engineering development in our

national and social life makes it imperative that engineers in the future assume a greater share in the control of these developments. This implies that the young engineer should learn to present his ideas in terms to be understood by the average man and that he should share in the political control of the nation. To do so he must learn to speak in public, to appreciate the social effects of technical changes, and to understand how men are influenced and governed. Junior-group activities should provide training in public speaking, discussion of social developments, and political debates. The late Dr. C. F. Hirshfeld did much to arouse the social consciousness of engineers and many of his addresses should be read again and again by our younger men.

The older members of our national societies have certain obligations to the junior members. The latter in joining a national society signifies that he is in a favorable and receptive mood toward that organization. This is the period when the older men should take particular interest in the new member; they should see that he becomes acquainted with other members and should encourage him to share in the discussions and the work of the society and of its sections. Such evidences of friendship and willingness to help on the part of his seniors enhance the regard of the younger man for his society.

Reference has been made to junior-group activities in the various societies. A notable movement of this nature was that undertaken by the Providence Engineering Society and described[1] by A. C. Chick.

Junior groups can organize classes for further educational development, round-table discussion of certain topics, or general meetings for the presentation of addresses by prominent men on subjects of particular interest to the young engineer. The New York local sections of various societies have inaugurated courses of lectures on technical subjects for their younger members and similar groups have been organized elsewhere. The requirements for licensing examinations in several states necessitate added instruction in some subjects and the review of others. This instruction may be organized by the junior groups. Such movements should be given every encouragement by the older members. A committee report[2] of The American Society of Mechanical Engineers on this matter will prove helpful in developing junior activities.

CONCLUSION

These considerations lead to the conclusion that the young engineer, both as a student and after graduation, should actively participate as a member in the work of his professional society. The national societies should give greater thought to means for affording junior members a share in their various functions and, further, that more consideration must be given to the question of remuneration for the young engineer. Finally, the young engineer will gain material advantages, both directly and indirectly, in his later professional life, by active participation in the work of his society from his earliest days in the field of engineering.

[1] "An Organization of Junior Engineers," by A. C. Chick, *Civil Engineering*, vol. 8, November, 1938, pp. 739–741.

[2] "A Study of the Relation of the Junior Member to the Society," Report of The American Society of Mechanical Engineers, New York, N. Y.

MOLTEN CAST IRON BEING DELIVERED FROM TILTING LADLE TO REVOLVING MOLD IN CASTING MACHINE

(Photograph taken by H. S. Hoffer and shown at the Fourth Annual Photographic Exhibit held during the A.S.M.E. Annual Meeting in Philadelphia, Dec. 4-8, 1939.)

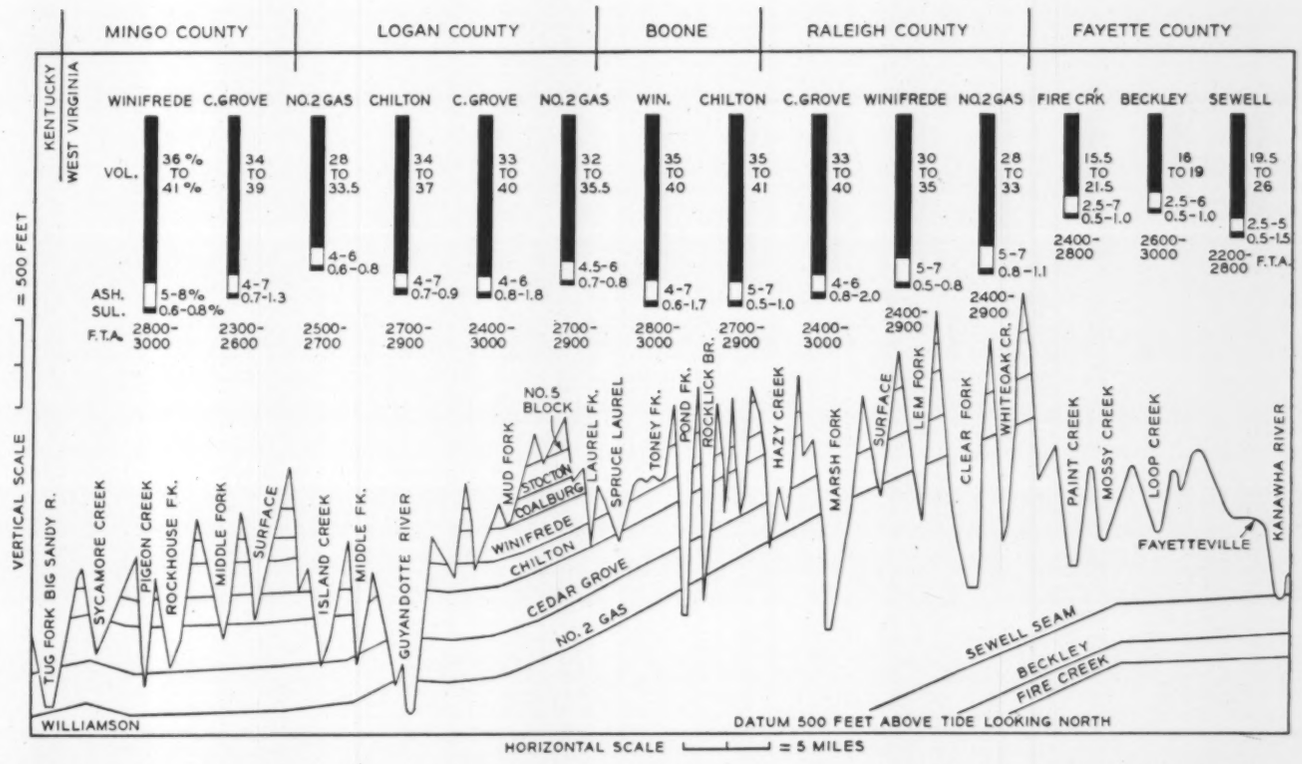


FIG. 1 CROSS SECTION THROUGH KENOVA, LOGAN, COAL RIVER, KANAWHA, AND NEW RIVER COAL FIELDS IN WEST VIRGINIA

BITUMINOUS-COAL-MINE LAYOUTS *and Operating* PRACTICES

Effect of These Factors on Consistency of Products

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FROM the beginning of mining to the end of 1937, there have been mined in the United States approximately 19,000,000,000 net tons of bituminous coal, and most of it has been used on this continent. Because of the magnitude of this industry, many problems are involved. It is the purpose of this paper (*a*) to point out to individual producers certain practices which may assist them in giving the customer as uniform a product as possible, and (*b*) to acquaint the consumer with the study and care given to, and the possible operating economics sacrificed in, producing as consistent a coal as natural conditions permit.

Geographical location influences coal value to a great extent. Thus, coal which would not be considered for use in one area may be of great value in adjacent territory, because of relatively low freight rates. However, the East and Middle West enjoy a choice of coals which is unsurpassed. This is best shown by Fig. 1, in which laymen should particularly notice that the horizontal and vertical scales are necessarily different. As a matter of fact, the coal beds lie practically flat. Fig. 1 shows a cross section through 75 miles of coal territory in southern West Virginia. The superimposed sections of the coal beds show volatiles ranging from 15.5 to 41 per cent, ash from 2.5 to 8, and sulphur from 0.5 to 1.8 per cent. Variations in ash-fusion temperature from 2200 to 3000 F may be found within this one area. It will be noticed that, generally, volatiles increase in a westerly direction. A cross section through Pennsylvania would cover the anthracite fields with volatiles as low as 6 per cent on through the low- and medium-volatile districts of central Pennsylvania, and westward to the high-volatile fields of Pittsburgh.

Such cross sections would lead the layman to think it an easy matter to pick out an area containing coal of his requirements and tie up with any mine in the location having the cheapest transportation rate. Fig. 2 shows columnar sections of the same seam in six different locations, all within one county, proving how far wrong he may be. It is true that the

Presented at the Joint Meeting of the Coal Division of The American Institute of Mining and Metallurgical Engineers and the Fuels Division of The American Society of Mechanical Engineers, Columbus, Ohio, October 5–7, 1939.

great variations shown are not common in many localities. However, most seams vary greatly, sometimes splitting from a small parting in one location to two separate veins, as much as 80 ft apart, within a distance of a few miles. This same seam may change its character entirely both structurally and chemically within the same distance. Later, the author will attempt to show that the different strata of coal in the faces of a mine may present as great a problem in obtaining consistency, as does removing the extraneous matter occurring between or above them.

PHYSICAL FEATURES AFFECTING MINING SYSTEMS

Plans showing proposed workings are laid out before a modern mine is opened. The engineers and mine staff later make certain that the workings follow the lines on the blueprint, just as a builder must follow the plans of an architect. Generally, the direction of mining is decided by the dip of the seam and cleavage of the coal, both ascertained before plans are prepared.

A close study of the strata lying between the coal bed and the surface should be made and the kind of material and approximate thickness of each stratum noted. Such information may be obtained from test-bore-hole cores and by observation of strata along streams. If another mine is operating in the immediate vicinity, its experience with roof control may afford valuable data.

Prior to operation, any weight of overburden is distributed evenly over the coal bed. When coal is removed, there is no solid support for the weight above the resulting openings. The extent to which such openings may be made without encountering costly trouble depends upon the kind and nature of the overlying strata. For several years, committees of the American Institute of Mining and Metallurgical Engineers have given the question of subsidence considerable study and their findings are valuable. The author has observed mines in which the roof material broke up when falling, becoming choked within five to six times the height of the opening, and other mines in which the top broke through 800 ft to the surface, creating crevices into which cattle fell, and for which at least one owner was sued for damages. Proper consideration of the overburden, in detailing mine layouts, can result in a more economical operation, greater consistency in commercial product, and better control of face preparation, as well as the avoidance of changes in practice to the mining system which are costly.

A detailed study of the coals should be made, if the mining of two or more seams to a common tipple is contemplated. Although two seams may seem identical by proximate analyses, it is possible for the product of one to produce a good foundry coke and that of the other an excellent blast-furnace coke. As the requirements for such cokes are vastly different, it would be a great mistake to mix two such coals. Also, the ash of one coal may not mix well with that of another in burning. The author knows of a coal from one particular mine which, while excellent for stoker fuel by itself, will cause clinker trouble on the furnace grates and side walls if mixed with other good coals. The actions of ash constituents is a subject still too little understood by consumers and chemists.

METHODS OF MINING

Most systems of deep coal mining are variations of two methods, the longwall method, mostly used in Europe, and the room-and-pillar method, generally employed in the United States. Modifications, particularly of the latter, are numerous and ingenious. These methods will be discussed in a general way, in so far as they affect the subject of this paper.

In the longwall method all of the coal is removed as the mine face advances. The space created by removing the coal is filled with packwalls of rock and dirt. Haulways from the main opening to the face are left in the packwalls. So great is the weight of the overburden upon the packwall that the rock bottom in the haulways is continuously forced up, necessitating removal to keep the way open. The dead work of "brushing" the haulways and building the packwalls absorbs much labor, so that the ratio of nonproducing to producing employees is high and, therefore, the per-ton production per man employed is low. Such a method is necessary in Europe where surface values are relatively high. It has great advantage in control of uniform face preparation and maximum coal recovery but would be economically impossible in the United States, where wages are higher and the competition with other fuels much keener.

By the room-and-pillar method, approximately 30 to 45 per cent of the coal seam, depending upon the system used, is removed as workings advance. A section of working faces is illustrated in Fig. 3. From the haulway, openings called rooms are made. Narrow places are driven between room and entry openings to permit ventilation. The blocks of coal remaining are called pillars. After the rooms have been worked to a predetermined distance, the pillars are removed. This process is

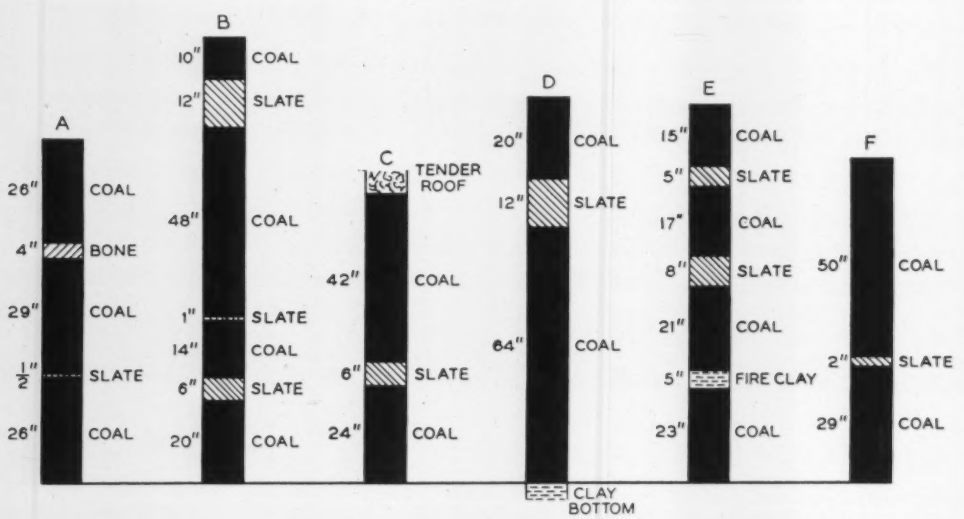


FIG. 2 TYPICAL FACE CONDITIONS AS AFFECTING ASH CONSISTENCY

generally known as robbing. In some cases the pillars are left for years after the rooms are worked and, in many old abandoned mines, they were not removed at all. The best practice is to remove them as soon as possible after the rooms are completed.

MINING SYSTEMS

The main object in good mining is to keep as much top weight off the pillars as is practical. Thus, thickness of cover and nature of overlying strata determine the limits of room width *A*, Fig. 3, and necessary pillar width *B*. They also limit

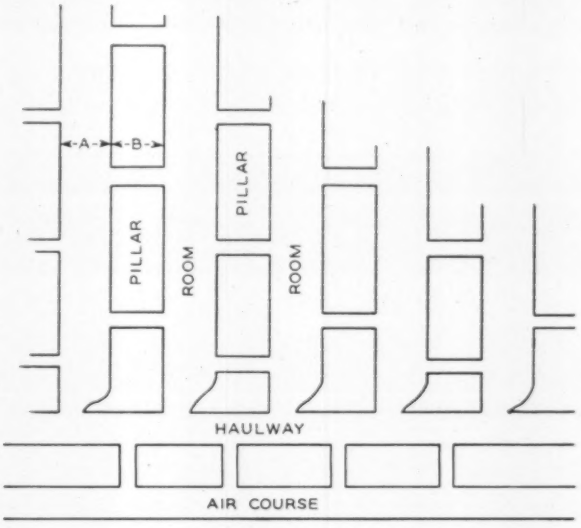


FIG. 3 TYPICAL ROOM-AND-PILLAR METHOD OF COAL MINING

the systems of advance and recovery which can be applied to local conditions. If pillars are too narrow, excessive weight will crush the coal and the impurity bands as well, thus lowering the sales return on the coal and reducing the impurities to a size impractical to remove at the face. Where pillars are to stand for considerable periods, they should be wider than they would be for immediate extraction. If rooms are too wide, they require excessive timbering and cause pinching of the coal along pillar ribs. Too much dependability is sometimes placed upon timber. It is compressible and deteriorates rapidly in a mine. As an immediate safety measure for the miner, it is permissible; but most of the props usually seen in a bituminous mine are far too small to keep much of the overburden off the pillars.

Assuming that the widths *A* and *B*, Fig. 3, are correctly determined, there are numerous systems for face-and-pillar extraction. Because pillar coal is much harder to clean at the face than the coal in advance mining, the old system of allowing pillars to remain until all of the advance coal was moved gave most consistent output. That system is fast disappearing and, in view of the growing clamor for conservation, for which the author holds no brief, may soon be outlawed. By the latest approved and most economical systems, pillars are robbed as soon as a panel entry is finished. In some cases, withdrawal of a pillar is started as soon as adjacent rooms are completed. Some pillar coal is machine-cut, but a considerable portion of it is mined off the solid, controlled roof pressure being used to some extent in breaking it loose. Naturally such conditions are not as conducive to good face preparation as those obtained in advance mining. There exists a great possibility for ash fluctuation over a day's output. Where entire territories, covered by individual gathering locomotives, are in dirty pillar coal, consistency may be obtained by mixing outside the mine. At least two loaded mine-car tracks should be supplied near the tipple dump, one for advance-mine coal and one for pillar coal. Since it requires a number of mine-car loads to fill a railroad car, by dumping the two coals alternately, as nearly as possible in the proportion which their tonnages bear to each other, a satisfactory ash average may be maintained. At mines of relatively small output, some mixing may be done by resorting to "layer loading." Railroad cars may be partially loaded with pillar coal and later shunted back for completing the load with advance coal.

NONUNIFORMITY IN THE COAL BEDS

The coal strata in a single face may differ materially in structure and chemical analysis. When extraneous strata are within the coal bed, the sections of coal, lying between such strata and between them and the main top and bottom, are called benches. Thus, if only one band of impurity is present, we have a top and a bottom bench; if two bands are present, we also have a middle bench of coal. Fig. 4 shows a two-bench face of gas coal. Incidentally, about 15 miles distant, a face in this same seam shows a hard gray splint coal.

In Fig. 4, the presence is indicated of four distinct strata of

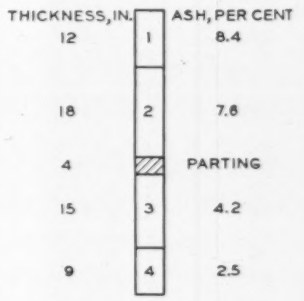


FIG. 4 ASH CONTENT OF COAL BENCHES

coal varying in ash content from 2.5 to 8.4 per cent, with an average for the total seam of about 6 per cent in coal alone. Here the firmness of structure increases with ash content, the top strata being harder than the others and the bottom strata being rather friable. This relation of hardness to ash holds generally in the southern gas coals and the central Pennsylvania coals. The author has taken samples of various run-of-mine coals from 1000-ton commercial shipments to ascertain the relative sizes in the product. Lump coal was first crushed to maximum 4-in. size because that was the usual procedure before burning the coal. The coal was screened into three sizes, 1 in. plus, 1 in. × 1/2 in., and 1/2 in. minus. In all of the coals so tested, the relation of hardness, and therefore size, to ash was constant so that one test result will suffice as an example. The 1 in. plus had an ash content of 12.06 per cent; the 1 in. × 1/2 in., 9.24 per cent; and the 1/2 in. minus, 6.4 per cent.

The writer has had no experience with this particular feature of coal beds in fields other than those mentioned, but the relation of structure to ash is an important one in preparation, particularly where face-mining practices must fit into the picture of shipping some sizes on special-purpose business. Subsequent discussion will show what an important part cutting and shooting can play in this connection. It is known that some shippers filling 2-in-minus orders have crushed lump to that size when lacking lump orders. Such a practice has frequently resulted in penalties or cancellations, due to excessive ash.

The strata, shown in Fig. 4, also differ in sulphur and volatile contents, the highest percentages being in the top stratum. The top stratum, having the hardest structure, should predominate

in the largest screened sizes It also happens that this face, if properly mined, could enter three separately distinct markets. The lump should be a fair domestic coal, the egg should go well for water-gas manufacture, and the resultant size should be ideal for metallurgical use. If indifferently mined, the same face will produce a mediocre coal, because its average 6 per cent ash will not stand much dilution by extraneous material, such as from the 4-in. slate parting. The relation of structure to chemical content, showing in commercial sizes shipped, is well covered in an excellent paper by J. B. Morrow and C. P. Proctor.[1]

Recently, the author had occasion to inspect a mine as a possible source of pulverizing fuel for a slag-bottom-type furnace. The mine had an excellent output from a two-bench seam of coal. The top bench was a fairly hard-structure blocky coal and constituted about 1/3 of the average coal thickness. The bottom bench was of a rather friable structure. Face samples were taken of each bench from several parts of the mine. Volatile matter in the two benches varied as much as 3.5 per cent, with all from the bottom bench being fairly uniform. The ash of the top bench exceeded that of the bottom bench by 6.9 per cent. Sulphur was about equal in both benches. Differences in ash-fusion temperatures of the two benches were most striking. The top bench was erratic, varying from an initial temperature of 2800 F in one face to a fluid temperature of 2750 F in another location. The bottom-bench ash was more consistent with low fluid temperature 2625 F and high fluid temperature 2675 F.

This was a marginal mine. Mining methods were good and most of the hard top bench went into prepared sizes. The natural slack came principally from the more friable bottom bench. The natural slack from this mine may give excellent results in some slag-bottom furnaces but, addition of prepared sizes, natural or crushed, would cause immediate trouble by slagging on the boiler tubes.

There are many more inconsistencies in coal beds than those referred to and shown in Figs. 3 and 4. In some fields, the beds contain what is called a rash, a mixture of coal and dirt. In some places in the Kanawha field of West Virginia and in other scattered locations, a stratum of cannel coal lies within other coal strata. In some fields, the top stratum contains so much ash and sulphur that it cannot be mixed with other coal and marketed. In one locality, the Cedar Grove top stratum, about 1 ft thick, is high in sulphur, while the balance of the coal is a good product for metallurgical use. The author has examined coal faces in many of the coal fields in North America, a few in South America, and a number in Europe. Variations in structure and chemical analysis of the coal and extraneous intrusions are not common to one mine, field, state, or country. Enough instances have been cited to show that shipment of a relatively consistent product day after day requires constant supervision of special treatment. Absolute consistency is impossible of attainment.

MACHINE CUTTING

The original objects of mechanical cutting were to enable the miner to produce a greater proportion of 2-in-plus-size coal and, at the same time, increase his daily output. At first all cutting was done in the bottom of the seam. The field has been extended to aid preparation, and machines are now manufactured to cut at any height and at any angle. A paper written by William Reynolds, Jr.,[2] treats the subject from an ash-control viewpoint and gives interesting data on the machines.

In most large mines, the cutting is done on an off-production shift to keep the machines from interfering with coal transportation during the day and to reduce electric-power demand. In such cases, the cuttings are the first coal loaded in the morning and, if they are dumped for shipment, the morning loadings of run-of-mine coal will contain a preponderance of slack coal and will not be representative of the total seam. It is also possible that slack coal may differ considerably at different loading times. If the analytic difference is serious, the only remedy would be to provide two mine-car dump tracks at the tipple, and to dump 1 car of cuttings to 8 or 10 cars of other coal in the ratio which cutting width bears to total coal height of the seam. This would, of course, mean more investment for mine cars.

Naturally the best place to cut is that location which will produce a product having the best demand and bringing the highest prices in the markets available. In many instances, consistency is of greater importance in holding customers than the amount of ash. Supply a customer with a 4 per cent ash coal, when his boiler, having a long firebox, requires 8 per cent ash coal and you will probably lose his business. Location of cutting can be of utmost importance in gaining consistency. The author knows of cases where operators changed from bottom to middle cutting with a substantial addition to capital investment. One such operator obtained an excellent reduction in average ash but the ash in individual railroad cars was extremely erratic. He also found that his percentage of prepared sizes dropped.

As a concrete illustration: Referring again to Fig. 4, we have three practical cutting locations. The best procedure would be to cut out the 4-in. parting and discard the cuttings. The two benches would then be clean coal and could be shot and loaded separately or together. In the latter case, the product would consistently represent the entire seam. Now, let us assume that the parting is too hard for economical cutting. We can then cut in the bottom coal and shoot the entire face at once. Again we have the complete seam. However, we also have the broken-up parting with it. The manner of shooting and nature of the parting will decide how much of it may be removed at the face. As the parting was too hard to cut, the shooting becomes the most important factor. Let us again assume that the parting does break up or the miners are lax in throwing it out. We decide to buy new machines and cut just above the parting. The top bench can be shot and loaded, after which the bottom bench can be shot. In shooting this bottom coal, the parting will be broken into slabs which the miners cannot hide but must throw out. We will have a much cleaner coal than by the second method of cutting, but what has become of consistency? During the morning, the miner will be loading coal, averaging close to 8 per cent ash and one volatile and sulphur content, while, in the afternoon, he will be loading coal below 4 per cent ash with other chemical contents.

These loadings from two distinct periods go to market in separate railroad cars. If the operator has business in the three markets previously mentioned, this last arrangement will be all right, but let him try to overlap or sell the product in an open market, then he is in hot water.

Where a top stratum is unsuited for a use for which the remainder of the seam is excellent, the cutting should be done just under it. Then the top can be allowed to remain in place or loaded separately, in accordance with economic conditions. In some instances, where the roof is tender or easily broken, it is the practice to leave some top coal in place to keep the air from the roof, and to prevent falling fragments from mixing with the coal. In cases such as this, top cutting prevents the

[1] "Variables in Coal Sampling," by J. B. Morrow and C. P. Proctor, Transactions American Institute of Mining and Metallurgical Engineers, Coal Division Class F, vol. 119, 1936, pp. 227–276.

[2] "Cleaning Bituminous Coal While Cutting," by William Reynolds, Jr., Transactions American Institute of Mining and Metallurgical Engineers, Coal Division, Class F, vol. 130, 1938, pp. 190–197.

shattering caused by the shooting of the remaining coal. Top cutting is desirable where the top stratum is unfit for market.

SHOOTING

Improper shooting can wipe out all of the precautions previously taken. The best advice which can be given is to shoot in such a way that the maximum percentage of prepared sizes will result. When the business was young, slack coal could not be sold, and miners were paid only for the prepared size they made. That generation of good shooters is gone. However, a scale of pay, according to size produced, would be a worth-while aid to preparation today. Some miners deliberately shoot heavily so they will not have to lift large lumps into the mine car. When shooting in this fashion, they shatter not only the coal but also the impurities so that much of them cannot be removed at the face. Only close supervision, or trained firers to do the shooting, will remedy this situation. Poor shooting can break up coal which is meant for one market, into a size which is desirable for another, and increase the ash in small sizes to the exclusion of their use by discriminating buyers.

ROBBING

More than half the coal in a mine area is left in pillars by first mining. Its recovery and preparation are governed by the degree to which the roof can be controlled. Here is where proper consideration of physical features of overlying strata in preparing mine layouts pays the largest dividends in percentage of recovery, maximum yield of coal sizes which bring the highest prices, and face control of preparation. All strata are elastic to some extent, and, in some, the extent is amazing. The author has witnessed the top of an opening 7 ft high bend almost to the floor without cracking. It is easy to imagine its crushing effect on the edges of the adjacent coal and impurities in place. The author has also seen such weight ride over entire sections of a mine in which the pillars remaining were too narrow. Such a condition is known as a squeeze. Any mine, having one occur today, is practically eliminated economically, because the coal and impure bands are all crushed. There can be little or no face preparation or use segregation there. Its coal could be sold only in very cheap markets after expensive mechanical preparation.

For many years, mines which machine-cut advance workings robbed off the solid. Today we have reached the point where much pillar coal is also cut. To make better use of costly machines on pillars, safety measures for controlling the roof are almost essential and the chances for face preparation are therefore improved. Where the pillar can be machine-cut, there are the same possibilities in face control as obtained in advance mining. Where pillars are shot off the solid, removal of impurity bands becomes more difficult and the chances for special-purpose segregations at the face are nil. Where cover is shallow and a good breaking top present, much better work is possible than under other conditions.

There are many so-called systems of robbing and each has its bearing upon preparation. The only general rules which may be advanced to aid preparation are to have a long robbing face at an angle best suited for pillar protection; break the top as close to the faces as possible to avoid overhanging weight of roof on the pillars; do not leave coal stumps which prevent a clean break of the roof.

MECHANICAL LOADING

High wage rates and close competition from other fuels have driven some operators to the new method of mechanical loading. It is not entirely an innovation but of late years mechanical loading has increased rapidly. In 1933 deep-mined coal so loaded amounted to 12 per cent. This figure has probably increased to between 18 and 20 per cent. It is, therefore, becoming an important factor in preparation.

The use of a loading machine practically precludes most of the face precautions outlined in this paper. Cutting must be done on the bottom bench. Cutting can be done in other places in addition, but any chance of special-use-coal segregation is doubtful. Shooting can be controlled and some large impurities can be removed from conveyers and mine cars but usually unit production makes this difficult. Shooting is usually harder than would be necessary for hand loading the same coal; therefore, thought must be given to possible reduction in sales realization. As all of the seam is loaded at one time, the ash is representative of the total coal plus most of the impurities. For the average mine an outside mechanical preparation plant must accompany mechanical loading.

SUPERVISION

If the supervisory staff is not clean-coal-conscious, clean coal will not be obtained, nor will the financial return be what it should. Good preparation and large percentages of prepared sizes go hand in hand and require strict supervision.

When preparation complaints come in from customers, the manager calls in his superintendent and inspectors and, in some cases, his supervisory force, and raises a rumpus. The entire force lands on the miners who in turn do not feel so good. Never has the author heard anything like: "The boys are doing better. We landed a 10,000-ton order which will give us an extra day a week for a time. Keep it up and we may nail that business for keeps." Such a word passed down would be understood and appreciated. Men need encouragement, incentive, and an occasional pat on the back.

GENERAL

Time and space do not permit discussion of the preparation problems presented by physical features incident to relatively small areas. A few such features are: (*a*) partial and total intrusions, called faults; (*b*) outbursts of gas; (*c*) mining under towns or large bodies of water; (*d*) tilting and folding of seams; (*e*) mass movements of whole areas causing crushing of coal. Such localized conditions have decided bearings upon face preparations.

To haul impurities to the outside is expensive and some surface plants are becoming hard pressed for disposal space. Where large mechanical loading units are in a mine it may be worth considering putting some rough preparation with them. A small screen, delivering lump material to a separate mine car, may permit removing large impurities, thus leaving them in the mine.

CONCLUSION

Coal in place is not a uniform product. Different strata vary in many essential elements. Every step from the planning of mine layouts down through all stages of production has some influence upon preparation. Sometimes such steps void the necessity of capital investments in expensive cleaning plants, thus leaving the coal in its natural state. Even when they are not sufficient, they save some investment by limiting the material necessary for mechanical preparation. Sometimes they may limit such preparation to one or two sizes of the product. The average operator does make an effort to ship as consistent a product as he knows how. It is hoped that discussion of this paper will give him new ideas. His present efforts cost money. If it were just a matter of mining and of shipping coal, its per ton cost to the consumer would be considerably less but, if the operator did just that, the consumer would pay more in the long run by way of freight charges on the extraneous material in the product and by reduced efficiency in his plants.

LABOR AGREEMENTS[1]

By W. RUPERT MACLAURIN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SINCE 1933, when the NRA first encouraged collective bargaining among workers, much has been written on the problems of labor organization, collective bargaining, the rights of employers, the responsibility of unions, the fairness or unfairness of government aid to unionization, and the wisdom or folly of the Wagner Act. Meanwhile management, often inexperienced in dealing with organized labor, has been faced with the very definite problem of negotiating an agreement with its employees. Many of these negotiations have undoubtedly been carried on without sufficient knowledge of the bargaining process, and also without knowledge as to what should or should not go into a collective agreement.

Mr. Lieberman has written a book[2] which should go a long way in assisting those who are trying to draw up an agreement. It is a practical book, and should be useful to every industrial-relations executive or negotiator who is not fully experienced in meeting union representatives. It will be equally useful to trade-union negotiators. The author, a member of the New York and Federal Bar, has had more than twenty-five years' experience in negotiation, and has been counsel for a number of well-known unions, among them the International Ladies Garment Workers Union, the United Furniture Workers of America, and the United Hatters, Cap, and Millinery Workers. This background should not deter employers, who are seeking guidance, from using the book. While Mr. Lieberman is perhaps not sufficiently critical of the weaknesses of the collective labor agreement, he has made a serious attempt at a dispassionate treatment of a subject which has too long been discussed in general and theoretical terms.

The book is divided into two parts. The first part, of thirty-four pages, is a concise statement of the historical background, the legal status, and the general principles governing the negotiation of the collective agreement. Chapter 1 covers the evolution of the collective agreement from English and colonial origins. It was not until after the Civil War, when our phenomenal industrial growth began, that collective representation of workers began to make substantial progress. The organization first of the Knights of Labor and later of the American Federation of Labor, gave workers their first real opportunity to make effective demands as to wages, hours, and working conditions, which are the principal subjects of negotiation in labor agreements. The Federation regarded the trade agreement as the "very essence of trade-unionism" and accordingly has pushed forward along this line for the last fifty years.

Of the first part of the book chapter 4 on "Negotiating the Collective Labor Agreement" is of particular interest. Most striking is the constant emphasis upon the necessity of reasonableness and fairness in the labor negotiator, as well as a thorough knowledge of conditions in the industry. Beginning this chapter with a definition of collective bargaining as "the process of carrying on negotiations concerning the terms of employment between the representatives of organized employees and their employers, which, if successfully consummated, results in a written collective labor agreement," the author cautions negotiators in straightforward language as to the necessity for industry-mindedness, reasonableness, and keeping faith. "Progressive labor," says Mr. Lieberman, "in presenting demands to employers considers such demands not only in the light of the immediate requirements of the workers, but also in the light of the needs and possibilities of the industry." And again, the negotiator "must sincerely strive to understand the employers' point of view and the problems that the employers may be confronted with as a result of the union's demands, and he must endeavor to seek a reasonable solution. . . . . The importance of keeping promises and keeping faith in the negotiations for a collective agreement cannot be overestimated. Honesty in a legal sense has a very limited application, but in industrial relations it is not sufficient merely to be legally honest. One must be intellectually honest."

The chapter concludes with a careful discussion of the more controversial issues in collective bargaining, such as the union shop, hiring and firing, machinery for adjustment of grievances, and the checkoff system. These pages are well worth a careful reading, and the tone of the foregoing brief quotations indicates the approach which the author makes to controversial questions.

Those who are interested in reading an employer's suggestions on bargaining strategy will find a brief article in *Labor Relations Reporter* of Dec. 11, 1939, a useful complement to Mr. Lieberman's book. While the corporation described remains anonymous, the author makes a number of practical suggestions, and emphasizes, as Mr. Lieberman does, the desirability of honorable dealing.

Part 2, pages 35 to 215, is entitled "Specimen Clauses With Notes on Problems and Legality," and constitutes a ready-reference guide to more than a hundred specific subjects frequently dealt with in collective agreements. Among those receiving fuller treatment are adjustment of disputes, enforceability of arbitration clauses, apprentices, breach of contract, checkoff, hiring and firing, guaranteed earnings and employment, work spreading, labor-saving devices, overtime, seniority, union shop, and employer-employee cooperation. Each subject is treated separately and follows a standard pattern. The problem is stated, giving the position both of labor and of management. The legal status of the subject is then discussed and is followed by clauses from actual agreements which bear on the topic under discussion. An effort has been made to include a wide variety of provisions bearing on the same problem and no attempt is made to advocate one or another. The author assumes that persons interested will select for guidance those examples which are most pertinent or suggestive for their particular situation. In each case the name of the union whose contract is quoted is given so that anyone interested can easily pick out contractual provisions existing in his own or related industry. Agreements of 132 different unions are cited and a list of these unions is given at the end of the book, as well as a list of court cases interpreting various aspects of labor law.

It would be unprofitable to try to discuss even a portion of

(*Continued on page 134*)

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "The Collective Labor Agreement, How to Negotiate and Draft the Contract," by Elias Lieberman, Harper and Bros., N. Y. and London, 1939., 233 pp., $3.

INDUSTRIAL PENNSYLVANIA STAGES A COMEBACK

By RICHARD P. BROWN

SECRETARY OF COMMERCE, COMMONWEALTH OF PENNSYLVANIA

I AM going to talk to you today with two objectives: First, to tell you about Pennsylvania's industrial comeback, a subject of interest to every engineer, whether or not he lives in Pennsylvania; and second to urge you to take a greater interest in politics, for the sooner we have more engineering in government, the better it will be for our country.

Like you, many years of my life have been devoted to engineering, and to a business which involved mechanical problems and, like many of you, I have been much concerned about the unemployment problem in this country, for if this problem cannot be solved, it may become a serious threat to our form of government, which affords us the liberty and the individual initiative unknown under any other form of government.

A recent public poll shows that the European war is considered to be the country's most important problem, and unemployment second. Wars come and go; we will be confronted with the unemployment problem long after the war has ended, unless we take constructive steps to solve it.

In 1937, I had the opportunity to visit some fifteen foreign countries and made a point of learning about the unemployment situation in each of these countries. When I left the United States, one out of every ten of our people was unemployed. In England I found one out of every fifty unemployed; in the Scandinavian countries—Norway, Sweden, and Denmark—one out of every eighty was unemployed. In Germany, one out of every thousand. In Russia, they told me there were no unemployed, but it is difficult to obtain any accurate information in Russia.

Here we are living in the greatest industrialized nation in the world, with the greatest natural resources and the greatest wealth. To have the greatest unemployment under such conditions, something must be "cockeyed."

On returning to our own country, I analyzed the Federal Unemployment Census taken that year to find that the State of Pennsylvania had 25 per cent more unemployed than the average state in the Union.

For years, boys and girls have been graduating from our schools and colleges to seek a job which they could not find. They had been brought up in the belief that they were living in a country which offered the greatest opportunity of any land in the world. It is not surprising, therefore, that at the outset of their careers they have become discouraged and their hopes are shattered.

Like many of you, I was raising a son and daughter in a land where their chances of finding employment were less than in certain other countries and, what was more serious, I was raising them in Pennsylvania with its record of 25 per cent more unemployment than in the average state. For their sake, should I move to some other country, where their future opportunity might be better, or into some other state, which might afford a greater opportunity?

You engineers have appreciated the problem of our fellow-engineers who in recent years have sought jobs which they were unable to find, and some of you have children who may someday have to look for jobs.

It appeared to me to be the duty of all of us, who could give the time, to help solve this important problem. Are we to take it lying down and say that we are licked—that the unemployment problem can't be solved—or are we to try and better conditions?

So when Governor James recommended to the recent session of the legislature of the Commonwealth of Pennsylvania the creation of a new department of commerce and asked me to serve as the head of this new department, I was intensely interested in undertaking the work.

Pennsylvania for a number of years has been suffering from an exodus of hundreds of its industries. Many of these industries had moved South. And what was more serious, few if any new industries were coming in to take the place of those which had moved out. In addition, we were suffering from high taxes necessary to support our exceptionally high relief load, which in part was due to this exodus of the industries which had supplied jobs for thousands of our citizens.

The first thing to do, therefore, was to try to reestablish confidence on the part of our Pennsylvania industries that we were going to do everything possible to cooperate and assist them to prosper and expand in Pennsylvania—to stop this exodus of industries from Pennsylvania.

Another objective was to interest industries in locating a new plant in Pennsylvania. We have a population of over ten million, with tremendous natural resources and a plentiful supply of skilled labor. We are close to the largest and richest markets. We have much to offer industry.

As you may know, Pennsylvania ranks first in the Union in the production of iron and steel products, hosiery, glassware, railway cars, leather, cigars, cement, and dozens of other commonly used products and, through this newly created Department of Commerce, we intend to tell the world what we have right here in Pennsylvania.

It is a strange paradox that this great industrial State of Pennsylvania uses 140 products with an annual value of $1,200,000,000 more than it produces within the state. Here is a tremendous market, close at hand, to supply the 10,000,000 people of Pennsylvania.

While Pennsylvania is the first state in the Union to set up a Department of Commerce with the broad powers conferred on it by the Pennsylvania legislature, I am confident that in the future you are going to see many states create similar departments to aid their commerce and industry.

You might ask what has been accomplished for Pennsylvania during the five months that this department has been functioning. So I will give you some examples to show the return of confidence in Pennsylvania and increased employment.

A Philadelphia manufacturer recently had a strike for five weeks and was threatening to move out. Upon our hearing of this, we made arrangements with the company to have a state mediator sent to the factory. Within a few days the strike was settled to the satisfaction of both the company and the union. The company has now decided to stay here.

An address delivered at a luncheon in connection with the Sixtieth Annual Meeting, Philadelphia, Pa., Dec. 4–8, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

A C.I.O. union at Langcloth, Pa., came to see me because the zinc smelter in which their men worked was threatening to close down because a 20 per cent reduction under the Canadian reciprocal tariff made it impossible for the company to operate. Some 700 employees would be thrown out of work. We promptly took the matter up with our senators and representatives at Washington and a hearing on the zinc tariff was granted.

An A.F.of L. union has been to see me regarding the threatened removal of a plant to the South and we promptly got in touch with the company and matters were worked out satisfactorily.

Our dress manufacturers of Pennsylvania were threatened by unfair trade barriers which were being developed in another state. I requested Governor James to appeal to the governor of the other state to investigate the matter, which he did, and the unfair trade barriers were eliminated, to the satisfaction of our Pennsylvania manufacturers.

Recently I had a conference with the representatives of a certain industry in Pennsylvania, where they were spending more time fighting each other than they were in trying to develop their business. They would not even meet together at the invitation of any member of the industry, but they were willing to do so when invited by us. As a result of this meeting a committee was appointed and is now studying the question of joint advertising of their Pennsylvania product.

The Viscose Company, with three plants in Pennsylvania, has been considering closing their Marcus Hook plant, which would throw some 1600 people out of work. We have been conferring with this company for a couple of months and I am glad to say that problems in connection with the operation of this plant have been satisfactorily solved and they have told me that they will continue to operate the plant.

I could go on indefinitely with examples of this kind, for we are daily being consulted by the industries of Pennsylvania about their problems. They now have a so-called "friend at court" to whom they can turn when they need help. Is it any wonder, therefore, that confidence is returning on the part of Pennsylvania business people that this is a good state in which to manufacture?

I would also like to give you a few examples of how our industries are expanding in Pennsylvania:

The Textile Machine Works of Reading, Pa., a division of the Wyomissing Industries, employing 10,000 people, have been doing their building the last few years in the South. This spring they started a $150,000 addition in Reading and have since planned two other additions in Reading, Pa.

The Pittsburgh Plate Glass Company is building a $1,700,000 addition to their Ford City, Pa., plant. They tell me that this is the first expansion program they have carried out in Pennsylvania for a number of years.

The Philadelphia Electric Company has just announced a $45,000,000 expansion program.

The Pennsylvania Power & Light Company has announced recently a $3,000,000 expansion program.

Our figures indicate that industrial expansion in Pennsylvania during 1939, and utility expansion to handle the increased industrial growth should far exceed $100,000,000 this year. I doubt very much whether any other state in the Union will show such a large industrial and utility expansion during 1939.

Between September 1 and October 31—a period of only two months—125,000 more people went to work in Pennsylvania.

The number of our people supported on WPA, by unemployment compensation, and relief, has dropped over 200,000 since June 1.

None of this increase in employment is due to foreign war orders. While I understand one plant in Pennsylvania has a foreign war order, production has not been started to date.

While I have a list of hundreds of factories which left Pennsylvania during the last few years, I know of no manufacturing plant of any size which has left Pennsylvania this year.

We in Pennsylvania, not by promises but by deeds, are endeavoring in every possible way to help our industries. Is there any wonder, therefore, that confidence is returning? And when we help our industries, we also help our retail business. When our factories are busy, our retail stores are filled with shoppers with money in their pockets and our workers are finding jobs by the thousands.

Pennsylvania, unquestionably, is making a great industrial comeback, and if I, by my small efforts, as one of your members, have been of help to Governor James, so in turn your efforts as engineers can be of material help in solving this unemployment problem throughout the nation.

For this problem is not going to be solved by politicians. It is going to be solved because men with your engineering experience are willing to help solve this great problem which confronts our country.

If you go into politics, don't do so to make money. No one ever does for very long. But, if you can find the time to take an interest in politics, in addition to your present work, do so, for this will be a better country in which to live when men like you take a greater interest in solving this problem.

In the future you may find time for more leisure—there will be many days when you cannot play golf—traveling abroad just now is none too healthful. If you turn to politics, you will find it is far more interesting than you thought. Your engineering training is well adapted for service to your country, state, or city. When we have more engineers like you and more engineering in government, we shall have better government.

Labor Agreements

(Continued from page 132)

the many subjects treated. Interest in various items will depend on the particular problem under consideration and will vary from individual to individual. One subject, however, might be selected as having general interest and that is the feasibility of industry-wide collective bargaining. The prevalence of this type of agreement in Great Britain and Sweden received wide publicity in the reports of the President's Commission on Industrial Relations, and was held up as an example of statesmanship in the field of labor relations. A trend is already noticeable in America toward the establishment of one agreement for members of trade associations which is, in effect, a step toward industry-wide contracts. Mr. Lieberman points out that whereas formerly unions in many trades were reluctant to deal with employers' associations, today they frequently prefer to do so. Such agreements have marked advantages for the union inasmuch as they strengthen the union's position, standardize labor conditions, and reduce cutthroat competition among employers in regard to labor costs. It seems probable, therefore, that unions will press more aggressively in the future for industry-wide agreements.

Mr. Lieberman regards the collective labor agreement as "a mirror of the progress of society in the development of democratic industrial relations between employer and employee." Whether or not everyone will agree with him in this, it is clear that he has made a real contribution to the practical aspects of negotiating a collective agreement. His book is also a very useful source of information on the current status of the trade-union agreement in this country.

A Plan of FOREMANSHIP TRAINING

An Adjunct to Profits and Better Employee Relations

By HENRY S. JONES

PRODUCTION ENGINEER, GLOBE-WERNICKE COMPANY, CINCINNATI, OHIO

FOR many years, foremanship training has aroused wide interest and discussion. Many books and articles have been devoted to this subject, particularly in recent years. A number of progressive concerns throughout the country have in operation foremanship-training practices, long since established.

The literature on this subject is so voluminous that the author will not attempt to review even a few of the books and articles devoted to it. Without reference to other methods in current practice, a plan which has been successfully pursued by the author's company for the last year and a half will be outlined.

Modern technique of foremanship training began in the early 1920's. When it was first introduced, the average chief executive regarded foremanship training in a more or less benevolent and disinterested way, whereas now he, himself, is anxious and willing to take a part in the training programs. In the beginning there was no sense of urgency nor necessity, but now good management recognizes foremanship training as a hitherto unappreciated but extremely valuable tool.

This marked change in attitude came on the heels of the last depression, which brought in its wake new laws, new labor problems, and, of course, the eternal necessity of cutting down costs. In addition, management suddenly awoke to the fact that employees as a whole listened with enthusiasm to outside agitators and spellbinding politicians, offering panaceas and promising Utopias; that they preferred to regard the efforts of good management toward better working conditions as a sop and a palliative for generally unsatisfactory economic conditions; and that they were quite forgetting that business as a whole, and their employers in particular, were possibly having a difficult time keeping the wheels turning and thereby continuing their jobs.

It was only a short step to the conclusion that management, itself, was guilty of not having passed on certain vital information to its foremen, who, in turn, are in the best possible position to pass on management's ideas and aims to the men. While this is not the sole function of a foreman, the situation, as outlined, presented a challenge to business and gave impetus to the current trend toward general use of foremanship training. Furthermore, the foremen, themselves, were beginning to wonder just where they fitted into the picture, and were actively seeking information about their jobs and how to improve themselves, as is evidenced by their enthusiastic reception of various sponsored programs for foremanship training.

METHODS OF APPROACH

There are three methods of approach to foremanship-training programs, through information, instruction, and conference. All three approaches have been embodied in the training program in question. However, before formulating any program details, the management attempted to ascertain the conscious needs of the foremen, and the reaction of the employees as a whole to the proposed training program. The information was acquired in two ways. First, a series of conference meetings was held with the union committee members and all the stewards, in conjunction with the superintendents and foremen. The initial meeting was opened with a cooperative talk on the part of management. All meetings were more or less open, and general discussions were allowed, permitting criticisms between foremen and union members.

The next method adopted for acquiring the essential information was to list the name of every employee in two files: One, an alphabetical file for ready reference, and the other, an operating visible-index file showing the employee's birthday, Fig. 1. As complete personal information as could possibly be obtained from the employee was also placed on the visible-index cards, such as, the employee's hobby, accidents, number and ages of his children, recent death or illness in the family, and other pertinent data. A general letter was then prepared, and its mailing timed so that it would arrive at the home of each employee on the eve of his birthday. The following day the chief manufacturing executive, who had written the letter, called on the employee in the factory. Since the birthdays were widely scattered throughout the plant, at the end of 3 months an excellent cross section of the employees' attitudes and thoughts had been gained. In a relatively short time there became available a comprehensive picture of what particular things were on the employees' minds, and just what had not been handled adequately by the foremen. As personal contacts are made, additional information is put on the visible-index cards for use the following year.

It was found from the preliminary meetings and personal con-

		Nº	AGE
CHILDREN	BOYS	2	5-19
	GIRLS	1	15

SOCIAL SECURITY Nº 270-24-2887

ACCIDENT RECORD
Lost first joint on first finger on each hand 9/12/20

HEIGHT 5'10" WEIGHT 145#

EMPLOYED-DATE	8/26/13
OCCUPATION	Sander
ALTERNATE	Sprayer
EDUCATION	High School
RELIGION	Catholic
HEALTH	Good
WORKMANSHIP	Good
ATTITUDE	Poor '38 Good '39

HOBBIES AND OTHER PERSONAL
Raising Carrier Pigeons
Had National Champion 1933 - One daughter married 1939

BIRTHDAY	NAME	ADDRESS
4/24/89	Doe, John	100 Main St., Norwood, O.

FIG. 1 TYPICAL PERSONAL DATA CARD FOR VISIBLE-INDEX FILE

Presented at a meeting of the Wood Industries Division of The American Society of Mechanical Engineers, Boston, Mass., October 12–13, 1939.

tacts, that a somewhat general misunderstanding existed as to just what were the company's policies, goals, and ideals, not only on the part of the union members and representatives, but also on the part of the foremen. In addition, it was found that the foremen were not ready for a strictly conference program, although they were as well prepared as most foremen who have not gone through this type of training.

FIRST DIVISION OF INSTRUCTION

As a basis for the proposed foremanship-training program, a Foremen's Club, which was to be a permanent organization was organized. The Foremen's Club was to meet twice a month at night. One meeting was to be a regular business meeting, and the other entirely social. However, during the training period they met once a week for 32 weeks The regular social meetings were omitted during the training period, but special social meetings were held at Thanksgiving, Christmas, and on other special occasions. A banquet was held at the conclusion of each of the two series of sixteen meetings.

Through contact with the workmen, and at the behest of the foremen, it was decided that the first part of the program should consist chiefly of informational and instructional procedure, divided into two parts. The method of instruction was adapted to meet the special needs of the company. It was handled by the foremen, and consisted of papers prepared and delivered by members of the group. Essential information was disseminated by the usual lecture method of presentation.

At the end of the first series, each member was given an opportunity to participate by instructing others of the group on some particular subject and demonstrating it to them. At each meeting, on the average, three members were given the floor for approximately 5 minutes apiece, in which time they discussed subjects selected for them the week before. General discussions were allowed after the delivery of each paper. The subjects covered in the first series were as follows:

The Walsh-Healy Act and Its Relationship to the Globe-Wernicke Company.
The Ohio Social Security Act.
The Wages and Hours Bill.
The Ohio Unemployment Compensation Act.
The Foreman and His Relationship to Accident Prevention.
Our Accident Program and the Ohio Laws for Compensation.
What Others Are Doing in Accident Prevention.
Wage-Incentive Plans Compared.
Discussion of Time Study.
Sweden's Labor Laws.
Labor Problems of Great Britain and Method of Solution
Better Ways for Production.
Production and Planning.
Problems of Management.
Cost Accounting at Globe-Wernicke Company.
Cost of Waste at Globe-Wernicke Company.
British and Canadian Trade Agreement.
Pan-American Conference.
Diagnosing the Dictator.
Research in Industry.
Does Reading the Trade Journal Pay?
What Makes a Job?

It is good practice and of great help to the men to select one of the many excellent textbooks on foremanship. For purposes of the course in question, Glenn Gardiner's "Better Foremanship" is being used as a text.[1]

Prior to each meeting foremen were expected to read designated sections of the text. Several meetings might pass without the chapters studied having been discussed. The president of the Foremen's Club arranged a series of surprise quizzes; not with the idea of embarrassing the men, but to determine whether or not the text had been studied. After the first of these surprise quizzes, which were always oral and unrecorded, the entire membership came well prepared. Some chapters were of particular importance, in which case they were assigned and reviewed by selected members of the club.

The informational procedure was handled by the executives of the company. The guiding text[2] for these lectures was Harrington Emerson's "Twelve Principles of Efficiency." At the inception of this series, a simple explanation was given of the stages of the business cycle. Charts were used, and simple and homely examples were demonstrated so that the foremen could readily understand the movements in the business cycle in relation to themselves.

Thirteen principles of management were developed as follows:

All Inclusive:

Higher common sense.

Primary:

1 Ideals
2 Personnel or competent council
3 Organization.

Secondary:

1 Planning and dispatching
2 Records, immediate, adequate, and reliable
3 Adaptation of conditions to work
4 Standards
5 Correct methods
6 Standard practice of instruction
7 Fair deal
8 Discipline
9 Efficiency reward.

These thirteen principles were presented not as a mere doctrine of efficiency, but as a philosophy and a workable code upon which to base the rules of practice, and by which to test the efficiency of any plant.

The application of the principles of management by the foremen, together with the benefits of their individual study, as previously outlined, effected a definite reduction in costs. The birthday letters and calls became an established custom and the change in the employee attitude was so apparent that it might be said to have changed in direct ratio as the course progressed.

SECOND DIVISION OF INSTRUCTION

At the conclusion of the first series, a recess of two weeks was held. We were then fortunate enough to secure, through the cooperation of the Ohio State Board of Vocation Education and the University of Cincinnati, the services of Dr. Ralph L. Jacobs. Dr. Jacobs led the second series of meetings. It was desirable to bring representatives from the engineering, accounting, purchasing, sales, and financing departments into a group conference with the factory foremen. Since this group would have been entirely too large to have made a successful conference, the foremen of the various divisions elected their representatives for the second instructional period, which was conducted by the conference procedure.

THE CONFERENCE PROCEDURE

In the words of Dr. Jacobs: "The principal objective of the conference method is to pool the experience of a group in the solution of a problem, and to promote definite, constructive, individual, and group thinking with a group of experienced

[1] "Better Foremanship," by Glenn Gardiner, McGraw-Hill Book Company, Inc., New York, N. Y., 1936.

[2] "Twelve Principles of Efficiency," by Harrington Emerson, book published by *Engineering Magazine*, New York, N. Y., 1912.

people. The technique of the conference procedure aids a foreman in analyzing his job, organizing what he knows and what he has learned through his own experience, and in profiting directly by the experience of others of the group." Table 1 gives these essentials of the conference method of procedure.

TABLE 1 IMPORTANT STEPS IN CONFERENCE PROCEDURE

Aim: To pool the ideas of a group when solving a mutual problem.

1	*Introduction*	Gain attention of group by telling a story, giving general treatment; then state topic and aim.
2	*Gather Data*	Secure facts and experiences of members of group; analyze problem into its elements.
3	*Classification of Data*	Organize data received by selecting items under definite classification.
4	*Evaluation*	In terms of importance or frequency emphasize pertinent material.
5	*Tentative Conclusion*	Arrive at some tentative answer if possible; reach a decision agreeable to a majority of the group.
6	*Planning*	Plan to make decision effective in every department.
7	*Try It Out*	Apply the conclusion arrived at in practice on the job.

The subjects selected and questions relating to them were directed along the following line:

1 What is wrong?
2 Who is responsible?
3 What can be done about it?

The meetings were conducted as informally as possible. The men sat around tables and were free to smoke or to talk to one another at will. Tables were used, since it was found that, if a man could lean on a table during a discussion, he was more at ease and, therefore, more apt to give his ideas to a group. Attendance was not compulsory and, as previously indicated, at no time during the entire course were any written quizzes or grades used.

The attendance and the minutes of the meetings were recorded. The latter were mimeographed and mailed to the members at their homes for review during the following week. A third and interesting record, which was used under Dr. Jacobs' direction, was the participation chart, Figs. 3 and 4. The members were not named, nor could they be identified, since each week the men occupied different positions.

The mechanics of the participation chart were quite simple. Whenever the leader addressed a question or comment to a member, an arrow was drawn on the chart to that member. When a member or leader made a general statement, an arrow was placed toward the center of the group. During general discussion, arrows were drawn from the various members who entered discussions among themselves. Conclusive ideas which came from a member were put on the board, and an arrow indicated that this member contributed to the boardwork. The sample participation chart, Fig. 2, was made at one of the earliest conferences. It showed that the leader had to do a great deal of prompting to get the group to participate. The sample participation chart, Fig. 3, which was made at one of the later conferences, indicates the greatly increased participation of all members. It was evident that they were interested and anxious to get their own ideas across to the group.

At the end of 16 weeks, these conference meetings were discontinued. Conferences are now held weekly in the shop by the superintendent of each division and his foremen. Some specific problem is taken up at that time and a solution arrived at if possible. The subject of one such conference was the proper use of trucks. As a result, there developed a surplus of trucks instead of the shortage which had existed previously. In the conferences held in the shop, the participation chart is not kept nor are the minutes recorded. However, a record of everything that is put on the blackboard is typed and distributed later to the participating group.

Next year it is planned to extend these courses to assistant foremen and executives of the union. In the meantime those who attended the conference sessions will hold conferences in the factory during working hours with various employees who have been selected as outstanding men. By continuing this process of training conference leaders, it is hoped that, within the next 2 to 4 years, enough conference leaders will be developed so that any problem pertaining to any department may be solved within that department by its members.

In conclusion, the foremen are developing a spirit of cooperation and coordination to a degree far greater than had been anticipated or hoped for by the management at the beginning of the courses. Grievances have dropped appreciably, and costs have steadily decreased. The program outlined requires a great amount of effort and time on the part of the executives and foremen. However, the results achieved have been gratifying, and have more than compensated for the extra effort required to place this program on a functioning basis.

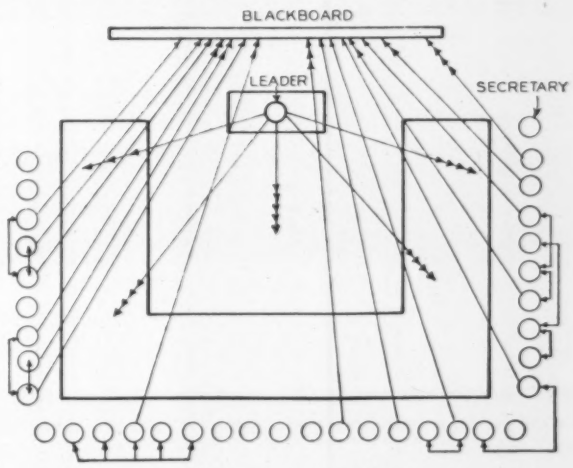


FIG. 2 PARTICIPATION CHART, FIRST CONFERENCE

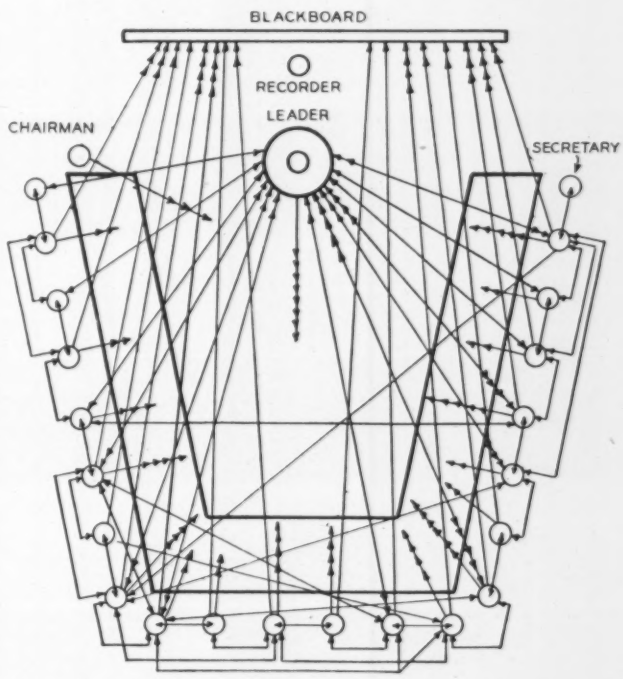


FIG. 3 CHART SHOWING PARTICIPATION IN CONFERENCE HELD TO DETERMINE REMEDIAL MEASURES FOR PROBLEMS EXISTING IN FACTORY

THE A.S.M.E. TODAY

III—Meetings of the Society Are the Result of Long and Careful Planning

WHEN the late F. R. Low, internationally famous editor of *Power*, was president of The American Society of Mechanical Engineers, he met authors of papers and presiding officers of technical sessions at breakfast and luncheon every day throughout the Annual Meeting of the Society and coached them in their respective duties. He explained that the Society had grown in numbers and in diversity of its interests so that it was no longer possible for everyone to gather in one auditorium where the president himself could preside. Instead, four or five sessions had to be convened simultaneously in different parts of the Engineering Societies Building, and the president was obliged to delegate to others the duties of his office. It was the one time above all others, he declared, when the Society threw open its doors and showed itself to the public. The prestige and the good name of the Society rested in the hands of those who took active part in the conduct of the sessions. Then, calling before him the presiding officers, he presented to them the gavels, symbols of his authority, and charged them to perform their duties with dignity and intelligence. It was a simple and impressive ceremony. It was the culminating precaution in a long series of preparatory actions and plans, initiated months previously, that were aimed at providing the most favorable conditions possible for the conduct of a technical engineering meeting.

The reasons for Mr. Low's precautions and his concern over impressing others with the obligations that were theirs were basically sound. More than any other activity in which the Society engages, its meetings reflect the quality and character of its work and affect its prestige. Too much time and money are spent by the Society, by the authors of papers, and by the 2000 engineers who attend an Annual Meeting, to risk failure of the meeting itself or even of one of its many sessions. And because long months of preparation and attention to innumerable details have always characterized A.S.M.E. meetings, these meetings attract busy men year after year and continue to grow in importance and popularity.

The present article, which is one of a series on "The A.S.M.E. Today," attempts to describe the steps in planning and conducting Society meetings and the general atmosphere that surrounds them.

COMMITTEE ON MEETINGS AND PROGRAM IS RESPONSIBLE FOR PLANNING AND CONDUCTING NATIONAL SOCIETY MEETINGS

Meetings of The American Society of Mechanical Engineers fall into four general categories: (1) National meetings of the entire Society, of which at present four are held every year, an Annual, a Semi-Annual, a Spring, and a Fall Meeting; (2) national meetings of the various professional divisions, at which subjects falling within the realm of technical interest of the division concerned are discussed; (3) meetings of local sections; and (4) business meetings. In the present article it is the intention to discuss national meetings of the entire Society and business meetings. Meetings of the divisions and of the local sections will be considered in other articles of this series that will deal with professional divisions and local sections.

Responsibility for arranging and conducting national meetings of the Society rests with the Standing Committee on Meetings and Program, although practically all Society committees and groups share some part of this responsibility. This committee is made up of five Society members, each of whom is appointed by the President for a term of five years. Every year one man retires and a new one is appointed to the committee. A junior member of the Society is also appointed to serve for two years in an advisory capacity in line with the Society's policy of providing active committee service for younger men.

By tradition, a member of the Committee on Meetings and Program becomes chairman during the fifth year of his term of office. Every member of the committee is assigned to some special group of duties at the organization meeting of the committee which takes place soon after the Annual Meeting. Committee meetings are held monthly except during the summer, or more frequently if immediate needs demand it. Close contact with other Society committees is maintained by means of the Advisory Board on Technology, on which the committee has a representative, through occasional meetings with other committees, and through the headquarters staff. The chairman of the committee serves on the Council in an advisory capacity without vote. Actions of the committee are subject to approval by the Council. Ernest Hartford, assistant secretary of the Society, serves the Committee as secretary, and is responsible for directing the staff work required by it.

FOUR-MEETING POLICY RELIEVES PROGRAM CONGESTION

When the Committee on Meetings and Program recommended to the Council that it adopt a policy of holding four national meetings of the Society every year, it had two principal objectives in mind. First, it wished to afford an opportunity for a majority of Society members to attend at least one major national meeting annually without having to travel excessive distances. The general plan now in effect, therefore, calls for an Annual Meeting, usually held in New York (about 25 per cent of the Society's members are in the Metropolitan area), and three other meetings held in some convenient city located in the industrial Middle West, on the Pacific Coast, and (in alternate years) in the South or in the Northeast. For example, in 1940 the Spring Meeting will be held at Worcester, May 1–3, the Semi-Annual Meeting in Milwaukee, June 17–21, the Fall Meeting in Spokane, September 3–6, and the Annual Meeting in New York, December 2–6.

The second important objective the Committee had in mind was to relieve the pressure on the Annual Meeting program. With the steady increase in the activity of the divisions and in the number of papers available for presentation, the time and space available within any reasonable period set aside for a national meeting are inadequate. Practical considerations limit the desirable number of sessions at a meeting to about 30, and the number of technical papers per session to two or three. Overlapping interests of members and the availability of meeting rooms for simultaneous sessions offer real difficulties in program making. It is obviously not possible to crowd all of the papers available for presentation into one or two national meetings. Furthermore, by holding national meetings in many different localities, it is possible to take advantage of the unique opportunities afforded in each of them by their citizens, plants, industries, and hospitality. Thus variety and richness are attained in national-meeting programs.

How national Society meetings are planned and conducted can best be illustrated by describing the procedure followed in the case of a typical Annual Meeting.

Preparations for an Annual Meeting begin at least a year in advance. One of the first tasks of the Committee on Meetings and Program, usually undertaken immediately after the Annual Meeting while impressions and experiences are still fresh, is to discuss the strong and weak features of the convention that has just closed. To provide a background for this discussion, members of the committee try to visit every session room and observe the success or failure of every feature of the program. Comments of Society members, of chairmen and recorders of sessions, and of staff members are reviewed. The reasons for the successes and failures are critically checked, new ideas are developed, and the technique of conducting successful meetings is continually improved.

By an arrangement that has been in force for several years, the technical sessions of the meeting are planned in cooperation with the Committee on Professional Divisions, the various professional divisions themselves, and some of the technical committees that sponsor papers and reports for public presentation and discussion. In order to provide a basis for program making, these agencies are invited to meet with the Committee on Meetings and Program, or its representative, in a conference held at least semiannually. Here the program is roughly laid out. Each group is asked to state the number of sessions it wishes to sponsor and to report any papers it may have available for presentation. Efforts are made to plan for joint sessions when subject matter is of interest to two or more groups. Dead-line dates for the principal steps in building up the actual program are announced, and every effort is made to simplify and coordinate the many tasks and steps involved.

For a meeting held in the first week in December the sponsors of technical sessions are required to file with the Committee on Meetings and Program before July 1 the names of authors and titles of papers to be contributed by them. The Committee then drafts a provisional program and almost constantly from then on checks with the sponsors and revises the details until a final program emerges sometime in the fall.

Every prospective author is required to submit an abstract of the paper he plans to present to the Committee on Meetings and Program through the appropriate agency of the division or Society group that sponsors his paper. These are reviewed by the Committee on Meetings and Program, not only for the purpose of safeguarding the high quality of Society technical papers, but also to make possible intelligent arrangement of sessions within the program.

A "ninety-day rule" requires submission of the paper itself to the sponsor group for review before the first of September. Review of a paper is the responsibility of the division or technical committee under whose sponsorship it is to be presented. Authors may be asked to revise their papers if the reviewers consider revision desirable, and they may be asked to condense them for publication. Once the paper is finally approved by its sponsor group, it is sent to the Committee on Meetings and Program by whom it is turned over to the Committee on Publications with recommendations concerning preprinting. Round-table and panel discussions are frequently handled less formally for obvious reasons.

Acceptance of a paper for presentation at a meeting does not guarantee its publication in Transactions or MECHANICAL ENGINEERING. Obviously, the number of papers presented at meetings of the Society in any one year is so great that funds are not available to publish all of them. Hence some papers of temporary interest, or on subjects of concern to relatively small groups of members, may be mimeographed. Decision as to the publication of a paper rests with the Committee on Publications, although the recommendations of sponsor groups are followed as closely as possible.

Under the rules of the Society it is within the authority of the Committee on Meetings and Program to remove from the program any paper not received in time for preprinting. This authority is granted because it is the policy of the Society to place emphasis on the discussion of the paper. Intelligent discussion presupposes, in most cases, that an opportunity to read the paper at leisure has been granted possible discussers. In line with this policy, each group is requested to submit, with the paper it plans to present, a list of persons who are to be invited to discuss it. As soon as preprints are available, copies are sent to these potential discussers, with the request that discussion be submitted in writing in advance of the meeting. Notice of the availability of preprint copies is published in MECHANICAL ENGINEERING so that any member of the Society may write for a copy for study before the meeting. At the entrance to the room in which the paper is to be presented, copies of the preprint are distributed for the convenience of the audience.

Further details on the solicitation, review, preprinting, and publication of Society papers will be presented in future articles on the professional divisions and the publications.

HOW TECHNICAL SESSIONS ARE CONDUCTED

Before leaving the subject of technical papers and sessions, a brief description of the manner in which these sessions are conducted should be attempted.

As is the case with any public gathering, the success of a technical session depends on the careful planning of many details and a certain amount of organization, showmanship, and stage setting. After all, the presiding officer and his little group of authors and assistants are putting on a show and their principal concern is to satisfy the audience.

Preparatory measures begin weeks before the meeting with the assignment of meeting rooms, attention to the needs of the author for special equipment—a stereopticon or a motion-picture projector with competent operator, blackboard or other stage furniture, attendants, preprints, and the like. A chairman or presiding officer and a recorder must be assigned for every session, and they must be provided with essential equipment, instructions, and information. A biographical sketch of every author is prepared, and copies of the papers and of any written discussions, and lists of discussers are put in "jackets" for use at the session.

In order to leave nothing to chance, every person who has responsibilities in connection with a day's sessions attends an authors' breakfast or luncheon from which all go in a body to the session room. In this way the presiding officer has an opportunity to meet his assistants and the authors and to discuss with them the procedure to be followed during the session and any special conditions that may need attention. Best of all, perhaps, the identity and presence of the chairmen and authors are established, so that all are placed at ease, and the sessions can commence at the scheduled hour. Thus most of the chances for failure are eliminated before the audience assembles. The "performers," at least, are ready, and with intelligent action on their part, the audience will be satisfied.

As a matter of policy, the object of which is to insure ample time for discussion, no more than two technical papers are presented at a session. However, when two or more papers are devoted to related subjects, or when a symposium of several papers has been arranged, this policy is not always adhered to. Moreover, at some sessions papers are presented by title, that is, they appear on the program but are not read, even in abstract, nor are they discussed. Sometimes reports of committees are admitted to a program on which the usual two papers also appear. At other times a single paper affords sufficient subject matter for discussion to appear alone.

By prearrangement the time allotted for the presentation of

each paper is set. The program announces the order in which every paper will be delivered, and every attempt is made to adhere to the announced schedule so that members whose interests may attract them to one or more of the concurrent sessions will know approximately when to expect presentation and discussion. Society rules give preference to prepared discussion, written and submitted in advance, provided the discusser is present to deliver it himself. Each person presenting a prepared discussion is allotted ten minutes. After all discussers who have sent in prepared discussion have been heard, discussion is invited from the floor, or the chairman calls on members present who may be competent to contribute comment. Each of these discussers is limited to five minutes, although by vote of the meeting the time may be extended.

It is the duty of the "recorder," the chairman's assistant, to keep a record of the names of the discussers and brief notes of the discussion. Following the meeting any member may submit discussion in writing; and the headquarters staff, guided by the recorder's notes, invites discussers who spoke extemporaneously to submit their remarks in writing for the record. Except in unusual circumstances, stenographic records of discussion are not made, first, because it has been proved that the expense is not warranted, and second because in many cases discussion is more frank and informative if the discusser is assured that his remarks are not being recorded verbatim.

The author is accorded the privilege of presenting a final rebuttal to all of the discussion and of answering specific questions asked by discussers before the next paper is called up for delivery or before adjournment is taken. He is also permitted to prepare a written "closure" to the discussion based on the form in which it is finally printed.

Attendance cards are filled out by the entire audience at every technical session. These are put to many uses. With the cards in front of him, the chairman may be able to spot a member of the audience on whom he can call for discussion if in his opinion that member is in a position to add to the value of the session. The cards also serve as a record of attendance; they are an indication of the interest of the members in the subject discussed; and they provide a means of checking division mailing lists.

SOCIABILITY AN IMPORTANT FEATURE OF SOCIETY MEETINGS

Although technical sessions form the major portion of Society meetings, and, perhaps, the principal reason for conducting them, they are by no means the only important feature of such gatherings. Lectures and formal addresses supplement the technical papers. Opportunities are afforded for scheduled trips to plants, industries, and points of interest to mechanical engineers. Dozens of committees hold meetings. Luncheons and dinners crowd the program. The juniors and the student members usually hold sessions of their own. "College reunions" bring together the graduates of a dozen or more institutions. The Council meets; there is a business meeting. The group delegates of the local sections spend many hours in a conference devoted to discussion of Society problems. A similar conference is held by delegates of the professional divisions. The annual banquet, followed by the Presidents' reception and a dance, constitutes the high point of the social program. A special program for the women, conducted by the A.S.M.E. Woman's Auxiliary, features teas, dinners, excursions, and sight seeing. The question is not, "What is there to do at an Annual Meeting?" but "How can I do all the things I want to do?"

To many members, the best part of any meeting is the opportunity afforded of renewing old acquaintanceships and making new ones. The lobby, the corridors, the lounges, and the Engineers' Club are busy places. A quickening glow of good fellowship prevails. More serious duties are forgotten in the warmth of greetings of old friends. Men become known to one another. The professional progress of younger men is marked year by year by the increasing circle of their acquaintances. Students and juniors, frequently under the friendly guidance of an older member, meet the distinguished engineers whose work they know or whose books they have studied. An informal organization of men who have been members for 35 years or more, known as the "Old Guard," invites as its guests at the Annual Dinner all student members attending the meeting from out of town. As years pass by the feeling of kinship that younger men acquire for this great group of their professional colleagues places them on that equal footing which convinces them of their part in it. Young men begin to acquire a feeling that they belong to this group and they return to their daily tasks quite as much benefited by this experience in the development of intangible qualities in their inner selves as by any specific knowledge they may have derived from technical discussion.

Society meetings, and particularly Annual Meetings, are also the occasions in which the mechanical-engineering profession does honor to its distinguished members. Honorary memberships are conferred; honors and prizes are awarded. Eminent engineers and persons in the public eye are invited to deliver lectures and addresses. In the short space of a few days and by means of impressive ceremonies and colorful social gatherings, rich sources of inspiration are tapped, ambitions and purposes are strengthened, ideals acquire fresh significance, and lives are enriched in countless ways. The humdrum of routine to which most members must return becomes vitalized with the possible rewards that conscientious attention to daily tasks and solid achievement may someday bring. In terms of spiritual values, Annual Meetings are particularly rich.

On no occasion are the varied experiences of an Annual Meeting brought more sharply into focus than at the annual dinner. By tradition, the great ballroom of the Hotel Astor is filled with a mixed company in formal attire—a company representative of every element of Society membership. Seating is prearranged, with a host and hostess at each table. Gracing the long "speakers" table are the officers of the Society, the past-presidents, the speakers, the representatives of sister societies, and a few honored guests. Near the speakers table are groups of the "Fifty-Year" men, the "Forty Fivers," and others whose membership in the Society covers periods of 35 years or more. Fifty-year badges are presented to those who have attained this status. Student-member guests of the Old Guard are introduced. Speeches are few and have had a reputation for high quality. Following the dinner, and while the floor is being cleared for dancing, the incoming and outgoing presidents, the secretary, and their wives receive the members, and conversation in the vast throng becomes animated. Dancing follows, and as the evening wears on the guests gradually take themselves home, leaving the dance floor to those young in spirit and in years.

In spite of the fact that about 2500 persons register at an Annual Meeting, no two of them will have identical experiences. Some come early and stay until the end. Some attend only one or a very few sessions. Some concentrate on technical discussions, others on social events. Some take in the plant excursions, others are shut up in committee meetings. Each benefits according to his opportunities and his capacity for making the most of his experiences. Few are disappointed, because enthusiasm is contagious in large groups. Some count the costs, others assess the benefits. But be it holiday or strictly business, the opportunity for profit is there. Few investments a young man can make bring such sure returns in professional enrichment as may be found at an Annual Meeting.

WOMEN ENJOY A SPECIAL PROGRAM AT SOCIETY MEETINGS

The problem of what to do with women who accompany members to A.S.M.E. meetings is satisfactorily solved by committees of local women, usually working under the auspices of the Woman's Auxiliary, which sets up a special program of entertainment that is carefully coordinated with the main program. A member of the Society's Committee on Meetings and Program is assigned the task of working in close cooperation with the Woman's Auxiliary and the local committee in order to provide assistance in the formulation of plans and the coordination of programs.

Upon arrival at the meeting headquarters, women guests find a reception committee awaiting them. Registration facilities and special recognition badges are provided and the special program of events for women is distributed. Opportunity is afforded for shopping tours, for sight seeing, for teas, luncheons, theater parties, and dinners, and provision is made to meet the individual requirements of strangers in the city. By the time the meeting is over, the women guests have become well acquainted, and, like the men, have renewed old friendships and formed new ones. On several occasions events at which the men are present, notably the tea, Honors Night, and the Annual Dinner, afford wider scope for social activity. No one need think that in accompanying her husband to an A.S.M.E. meeting she will be forced to spend several days alone in a strange city or sit patiently at his side in technical sessions that afford her no profit or amusement.

LOCAL COMMITTEES OF GREAT ASSISTANCE

Three of the national Society meetings held every year take place outside New York as already explained. Although many of the details, particularly such as relate to the preparation of technical programs and the conduct of technical sessions, are carried out in a manner similar to that followed in the case of the Annual Meeting, there are differences. Because of the locations of these gatherings and their remoteness from headquarters, a distinctly regional influence is added to the national characteristics. Great reliance must be placed on the local section of the city chosen as the meeting place, not only in the handling of mechanical details but also in setting the character and content of the program.

Decision to hold a national Society meeting in a given city is made by the Council on recommendation of the Committee on Meetings and Program which has referred to it invitations on the part of local sections to act as hosts on these occasions. These decisions are made well in advance. In making its recommendation to accept an invitation the Committee on Meetings and Program is guided by many factors, such as a wisely planned sequence of meeting places properly distributed geographically within the general area in which a particular type of Society meeting may be held, accessibility of the place and facilities it affords for conducting a national meeting, the local engineering and industrial environment, and the ability of the leaders of the section to formulate and carry out the necessary plans.

After decision has been reached to hold a national Society meeting at the home city of one of the local sections, steps are taken months in advance to coordinate the plans and duties of the local group, the Society committees, and the headquarters staff. One of the first of these is the organization by the local sections of numerous committees. On nomination by the executive committee of the local section, a Local Executive Committee is appointed by the Committee on Meetings and Program. Necessary contact between the Society committee and this local committee is maintained through Ernest Hartford, assistant secretary of the Society, who makes frequent trips to the proposed place of meeting to discuss plans with the local committee and to give it the benefit of the Society's long experience in the handling of conventions and program making.

In order to aid the Local Executive Committee in its task, the Committee on Meetings and Program has prepared a manual of suggestions. This manual proposes an organization of committees and specifies the duties of each committee. A brief outline of these duties will give some indication of the details that must receive attention locally, and, perhaps, emphasize to the average member the extent of the task of planning and conducting a national Society meeting for his benefit.

WHAT THE LOCAL COMMITTEES HAVE TO DO

The Local Executive Committee is usually made up of the chairmen of the subcommittees described in the following paragraphs. This executive committee must: (1) Develop a program of plant trips and entertainment events; (2) cooperate with the Committee on Meetings and Program in arranging the technical program (the principal technical sessions and the technical papers to be presented are laid out by the professional divisions and technical committees as in the case of the Annual Meeting); (3) appoint subcommittees; (4) prepare a budget; (5) outline the duties and approve the plans of the subcommittees; (6) supervise the conduct of the meeting; (7) pass bills for payment by the local finance committee; (8) after the meetings, prepare a report for the Committee on Meetings and Program; and (9) issue formal letters of thanks to persons and organizations who assist in the conduct of the meeting.

The local Finance Committee (1) receives funds appropriated by the Committee on Meetings and Program for local expenditures; (2) receives income from all meeting activities; (3) passes bills approved by the Local Executive Committee; and (4) presents a report of finances to the Local Executive Committee.

The Hotel Committee (1) arranges with a hotel for meeting rooms and social functions; (2) keeps in touch with hotels prior to the meeting to insure proper handling of room reservations made by visiting members; and (3) stations its representatives in hotels during the meeting to see that reservations made by members are properly filled.

The Technical Events Committee (1) arranges for meeting rooms in cooperation, if necessary, with the Hotel Committee; (2) assists in procuring local papers, if desired, and upon request of the professional divisions; (3) cooperates with the Committee on Meetings and Program in soliciting discussion of technical papers from local engineers; (4) secures the necessary equipment for meeting rooms; and (5) supervises the conduct of technical sessions in cooperation with the Committee on Meetings and Program.

The Reception Committee (1) welcomes guests at registration headquarters throughout the meeting; (2) promotes acquaintanceship; and (3) provides for special attention to be accorded prominent guests and members.

The Entertainment Committee plans and conducts all entertainment functions, and for this it generally appoints a subcommittee to handle each separate function.

The Plant Trips Committee (1) plans visits to industrial plants and other points of interest; (2) provides necessary transportation for these trips; and (3) conducts all plant trips and sight-seeing tours of general interest.

The Women's Committee (1) plans the program for the women guests; (2) cooperates with the Entertainment and Plant Trips Committee; and (3) provides a reception committee of ladies which has charge of a general headquarters for women guests.

The Printing and Signs Committee (1) prepares all local printed matter, including printed programs not prepared by

Headquarters; (2) prepares signs required by all committees; (3) requests from headquarters badges of the type and in the number required, and distributes these badges; and (4) places all signs during the meeting.

Information, Registration, and Service Bureau (1) conducts the registration of members and guests attending the meeting; (2) maintains an information bureau; and (3) provides such miscellaneous services as paging and guiding.

The Publicity Committee (1) secures publicity in local newspapers; (2) furnishes headquarters with adequate information for advance publicity in MECHANICAL ENGINEERING and for circulars, and the daily and the technical press; and (3) cooperates with the Society publicity service in nation-wide publicity.

SOCIETY BUSINESS MEETINGS PROVIDE FORUM ON ITS AFFAIRS

Because The American Society of Mechanical Engineers is an organization of individuals all of whom have a voice and a vote in formulating the policies of the Society, the business meetings are important factors in providing a necessary forum for the discussion of strictly Society affairs.

While business meetings are required to be held at both Annual and Semi-Annual meetings of the Society, the Annual business session is usually the more important because at that time the Council renders the account of its stewardship, and the Nominating Committee is elected.

The Constitutions and By-Laws of the Society contains the following important provision about business meetings:

1 An action of a business meeting of the Society shall be deemed an action of the Society as a whole. Any expenditure required by such action is subject to approval and authorization by the Council (C9-5).

2 The Council or one per cent of the membership may call a special business meeting (C9-3).

3 Fifty corporate members constitute a quorum at business meetings (C9-4).

4 A proxy may be given to a member entitled to vote, but shall not be valid more than six months (B3-2).

5 At business meetings amendments to the Constitution may be presented by twenty members. The amendment cannot be adopted at the meeting but may be referred to the membership by letter ballot.

The geographical spread of the Society has resulted in other procedures by which the individual participates in Society policy making. The conferences of local sections and of professional divisions and the selection of Directors to give better geographical representation on the Council have served most useful purposes in this regard. In addition to these, the business meeting is an important element in the conduct of Society business.

CONDUCT OF SOCIETY MEETINGS IS A HIGHLY SPECIALIZED BUSINESS

The foregoing description of how national Society meetings are planned and conducted has attempted to touch on some of the important features that must be considered if successful meetings are to be expected. It is evident that this is a highly specialized business which involves innumerable details. The average member sees little of the machinery, knows less about the immense amount of work that is involved, and judges the meeting he attends largely from impressions he carries away with him. One object in describing a few of the principal details that must be given attention when the Society stages a national meeting is to attempt to convey an impression of what is involved and to awaken in members a realization of the debt they owe to the men who serve voluntarily on the many committees charged with responsibility for successful conventions. When it is considered that the bulk of the work connected with a Society meeting is conducted by men who must, at the same time, carry on the customary tasks and responsibilities of their own jobs, the truly democratic and cooperative quality of Society membership is strikingly brought into review. In terms of loyalty to their Society and their profession, the services of these men, voluntarily given for the benefit of their fellow members and the public, work on Society meetings takes on a high value. So long as this loyalty persists, the A.S.M.E. will continue to meet in an able manner the obligations implicit in its stated objectives. The means by which these obligations are met in planning and conducting Society meetings are representative of democratic traditions. The contributions made to the success of the meetings by the many members who take part in the planning and operating duties constitute real services to the public, as well as to The American Society of Mechanical Engineers.

Drawn by Lili Réthi

ENGINEERING SOCIETIES BUILDING LOBBY IS SCENE OF ANNUAL MEETING REGISTRATION

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

SINCE the trend of world events was last noted in these pages much has happened. One of the "pocket" battleships, facing a superior number of opposing warcraft which were, however, inferior in armament, was chased, badly damaged, into Montevideo harbor where it was later sunk by her own crew when ordered to leave. Confidence in the superiority of a ship that can outshoot anything it cannot outrun has been questioned as a result of this incident.

Many persons in this country who had a sympathetic interest in the Soviet experiment and a naive faith in the nobility of motives the "people" were supposed to have were rudely awakened by the alliance of two countries representing to them apparently opposite philosophies of government which most persons had long ago recognized as two forms of complete dictatorship under different names. The attack on Finland completed the disillusionment. What some had fearfully announced as the superior effectiveness of a dictatorship over a democracy was also called into question when it was demonstrated that the "lightning" mechanized warfare that proved so successful in Poland had bogged down on all fronts in the campaign against Finland. The democracies, although severely threatened, have taken heart as the turn of events has shown that they are not as helpless as their enemies have proclaimed them to be.

In this country those who have been so loudly asserting the decadence and death of our traditional economic and social procedures are finding it difficult to explain the failure of the substitutes they have devised. The failure of pump priming has been rather successfully demonstrated. We still have an inexcusable number of unemployed persons, our annual deficits have become chronic and have boosted the national debt to a staggering amount, and, as has been pointed out previously in these pages, we face the necessity of additional expenditures for national defense in about as unfavorable a borrowing condition as a country not at war could imagine.

As one of the rifts in the clouds that hover above us may be cited the attack which the Commonwealth of Pennyslvania is making upon its industrial and economic problems, brought to the attention of A.S.M.E. members at the 1939 Annual Meeting of the Society in Philadelphia by one of their own number, R. P. Brown, newly created secretary of commerce for the Commonwealth. Mr. Brown's account of Pennsylvania's "comeback" is printed in this issue.

Indications along the labor front point to some actions' being taken by the Congress on the Wagner Act and the National Labor Relations Board. Events too numerous to mention have demonstrated the need for change and thoroughgoing attention to the problems of labor. The abysmal quality of labor leadership reached an all-time low when the mention of John Lewis' name was forbidden on the Chicago stage. Such abuses of power tend to force the pendulum in the opposite direction and discredit the labor movement. Investigation of the NLRB and decisions of the Supreme Court have further emphasized the need for immediate and intelligent revision of the Wagner Act and its administration.

Personalities

Retirement of Owen D. Young, chairman of the board, and Gerard Swope, president of the General Electric Company, has been announced since our December issue. Both are highly regarded by engineers and both have made important contributions to public life, international affairs, and the electrical industry. Philip D. Reed becomes chairman of the board and Charles E. Wilson, president.

The Edison Medal for 1939, highest honor of the American Institute of Electrical Engineers, has been awarded Philip Torchio, retired vice-president, Consolidated Edison Company of New York, Inc. Mr. Torchio, a native of Italy, came to this country in 1893 and was employed by the Sprague Electric Elevator Company until 1895, when he joined the engineering staff of the Edison Electric Illuminating Company of New York. His connection with that company and its successors continued until his retirement in 1938.

PHILIP TORCHIO

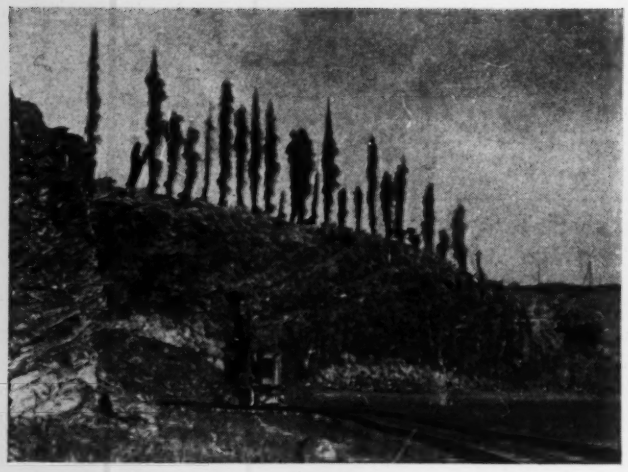
On December 17, 1939, John A. Hunter, professor of mechanical engineering at the University of Colorado, Boulder, Colo., fellow A.S.M.E., and member of the A.S.M.E. Council from 1932 to 1937, died following a period of ill-health.

On November 21, 1939, C. W. Spicer, member, A.S.M.E., vice-president, Spicer Manufacturing Corporation, makers of universal joints, died at Miami, Fla. Mr. Spicer had served the A.S.M.E. as chairman of its Standards Committee and the A.S.A. as chairman of the Sectional Committee on Small Tools and Machine Tool Elements. He was president of the S.A.E. in 1938 and chairman of its General Standards Committee, 1934–1937.

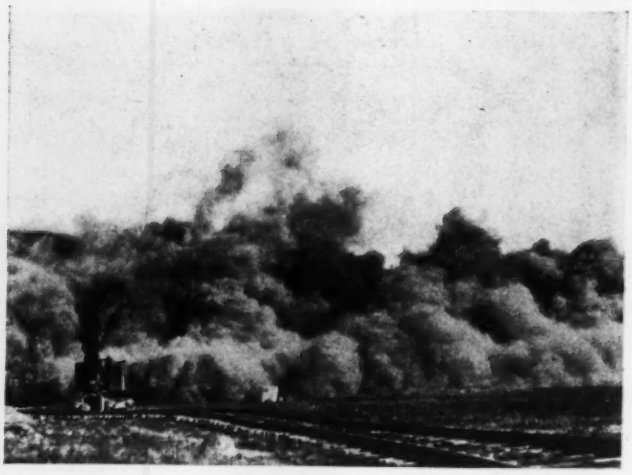
On December 26, 1939, occurred the death of Henry L. Doherty, member A.S.M.E., and president, Cities Service Company. Mr. Doherty entered the Columbus Gas Co. at the age of 12 and from then on his life was identified with public utilities and the petroleum industry.

Dynamite

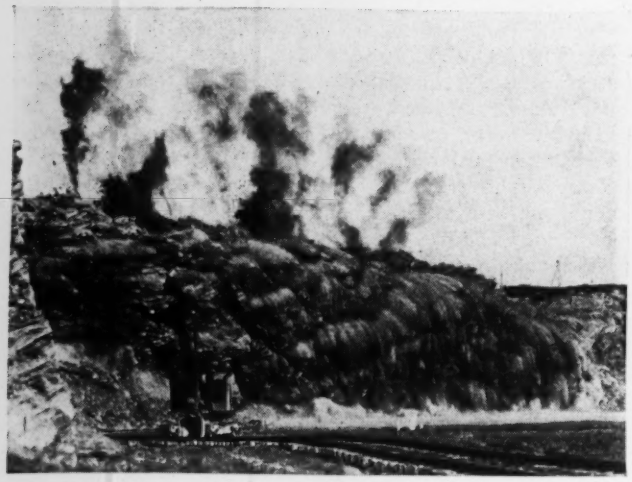
Not far from Easton, Pa., where MECHANICAL ENGINEERING is printed, at the Sandt's Eddy plant of the Lehigh Portland



(1) THE START OF THE BLAST



(3) THE SMOKE ROLLS DOWN THE VALLEY



(2) THE WALL COMES TUMBLING DOWN

(4) 86,000 TONS OF ROCK STREW THE FLOOR

Cement Co., on November 17, 1939, several score members of the Newcomen Society who participated in a two-day meeting devoted to the history of the steel and cement industries were witnesses of a blast of 14 tons of dynamite that dislodged and fractured into small pieces some 86,000 tons of rock. The Newcomen members were guests of the Lehigh Portland Cement Co. and its president Joseph B. Young, who addressed them at dinner on the same day on the history of the cement industry of that district.

Through the courtesy of Mr. Young a set of photographs of the blast taken by representatives of the *Call-Chronicle* newspapers, of Allentown, Pa., has been made available. Four of the photographs, taken from a point much closer than that where the Newcomen members stood, are reproduced in these pages. They show three stages of the spectacle and the face and floor of the quarry after the blast. James A. Gish, member A.S.M.E., superintendent of the Lehigh Portland Cement Co., who was standing with the Newcomen members, signaled across the valley by means of a large red flag for the firing of the blast.

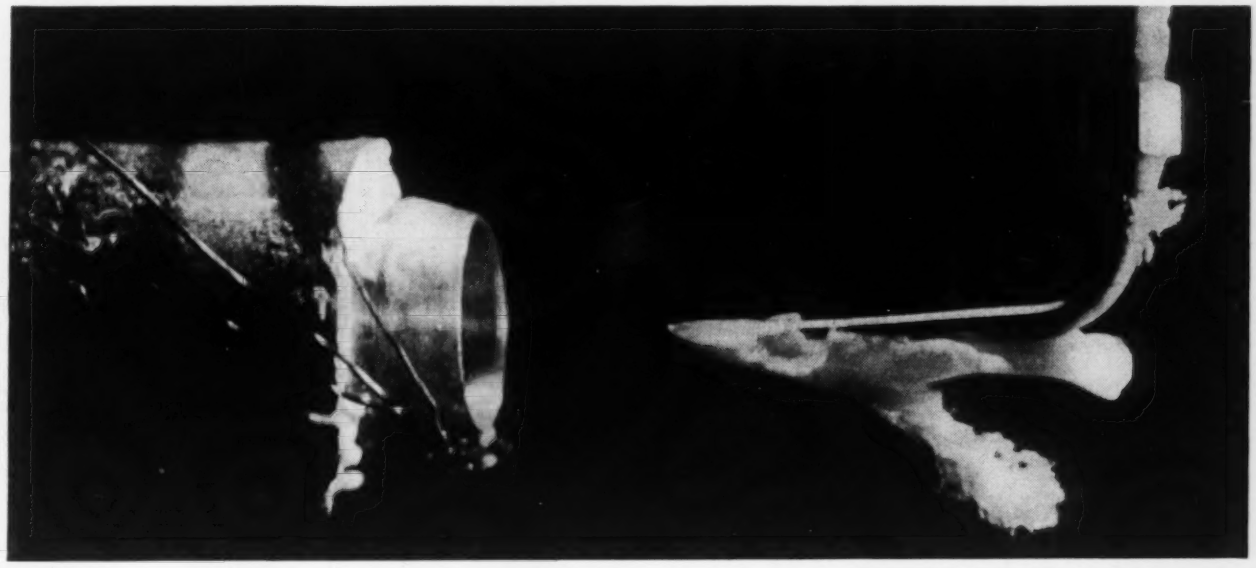
For the following notes we are indebted to Benjamin L. Miller, professor of geology, Lehigh University, Bethlehem, Pa.

The rock quarried at the Sandt's Eddy plant is the famous Jacksonburg limestone of Ordovician age. Unlike the stone in most cement localities, this limestone contains all the essential materials for the manufacture of Portland cement, mixed by Nature during its deposition in almost exactly the proper proportions. The Jacksonburg limestone comes to the surface in a band, up to two miles in width, extending continuously between the Delaware and Lehigh rivers and discontinuously westward from the Lehigh River and eastward into New Jersey. A string of cement plants shows the location of this valuable band of rock. The following data concerning the blast were furnished by the company.

BLAST IN NO. 3 QUARRY OF LEHIGH PORTLAND CEMENT COMPANY, SANDT'S EDDY PLANT

27 holes as follows: 20—108 ft deep, 2—104 ft deep, 4—78 ft deep, 1—61 ft deep
Holes drilled 6 in. diam 6 ft below bottom of quarry floor
Holes spaced 35 ft back of face on 14 ft centers
Total tonnage to be blasted, 86,000 tons
Dynamite used, du Pont Gelex No. 1
16,000 lb, 5 × 18-in. cartridges
12,400 lb, 4 1/2 × 24-in. cartridges

Total 28,400 lb = 3 tons blasted per lb of powder
Average 1050 lb powder used per hole. Only two blasting caps used to fire shot. No exploders used
Primacord used for detonation in conjunction with two blasting caps
Shot fired by hand-operated battery
Loading time, 4 hours.



ICE IN STEAM

(Ice forming on a search tube which is held in a stream of steam expanding in a nozzle from 100 psi abs, saturated, to a back pressure of 0.025 psi abs. This back pressure is below the ice point, and consequently the water droplets in the stream freeze when they encounter the surface of the tube. The stream itself is not sufficiently dense to be photographed, although it can be seen. Photographed by J. I. Yellott, during a research program on steam-jet ejectors which is being carried on for the Worthington Pump and Machinery Corporation, at Stevens Institute of Technology, Hoboken, N. J.)

Textiles of Tomorrow

AMERICAN DYESTUFF REPORTER

AS REPORTED in the *American Dyestuff Reporter*, Dec. 25, 1939, Kenneth H. Barnard, chief chemist of Pacific Mills, gave a talk recently before the North Jersey Section, American Chemical Society, in which he reviewed the latest developments in synthetic textile fibers, all of which have been described in this section in previous issues of MECHANICAL ENGINEERING: Nylon, November, 1938, and January, 1939; spun rayon, December, 1938; fiber glass, October, 1938; and synthetic wool, September, 1939 (page 664). Today, stated Dr. Barnard, more pounds of rayon are produced than pounds of silk. Even Japan, whose major export material was once silk, has been smart enough to shift so rapidly to rayon production that she is at present one of the world's greatest rayon manufacturers.

In the actual fabrication of goods, tomorrow's textiles may eliminate 90 per cent of work and machinery by taking a clean fiber in a thin gossamer web off the cotton-carding machines and "weld" sheets of the cobweb material with a fine spray of latex, cellulose acetate, or cellulose nitrate without any spinning, twisting, reeling, or weaving operations. This process is already being used in the manufacture of bandages. At M.I.T., according to the speaker, a chemical treatment has been developed for buffing-wheel cloth which increases its life as much as 50 per cent. For those unfortunates who have to polish the family silver, textile chemists have impregnated a flannel bag with millions of tiny particles of silver which immediately unite with and hold back any sulphur gases in the air before they can reach and tarnish the silverware within.

Then there is the trend of utilizing the new synthetic resins which are crystal clear, insoluble in soap and water and in dry-cleaning solvents in place of the older finishing materials such as starches, oils, and softeners, which are gone when the goods are first laundered. Tomorrow's textiles will be softened or stiffened, made resilient, that is, crease-resistant or crush-proof, made slip-proof and nonfraying, and strengthened or stabilized through the use of modern resin finishes. Although some fabrics are being finished with resins, many of these methods are so new that the textile manufacturers themselves do not know the best way to use them and are anxiously awaiting consumer reaction to express itself.

Another way of obtaining a permanency of finish is to remove the degradation products of cellulose from cotton cloth without touching the pure alpha-cellulose, thereby getting a cleaner, purer, stronger, and more lustrous cotton than by any other method in use today. In other words, cotton yarns are rayonized in the piece. It is also possible with this method to start an incipient fusion of the yarns where they cross in the woven piece, thus partially cementing them together and giving a certain crispness and stiffness to the fabric which will withstand repeated washing without change.

Radiation and Psychrometry

COLLEGE OF ENGINEERING, CORNELL UNIVERSITY

A MATHEMATICAL method of computing the effects of radiation on the readings of thermometers is set forth by Dr. David Dropkin in Bulletin No. 26 of the Engineering Experiment Station, College of Engineering, Cornell University, issued in October, 1939. The fact that neither the dry-bulb nor the wet-bulb thermometers, employed in the usual psychrometers for determining humidity in air, indicate the true temperatures, because they may both be affected by radiation from surrounding objects, was pointed out in a previous bulletin of the University. With especially designed apparatus, data have now been secured and equations developed to calculate the corrections for radiation of thermometers under varying conditions.

Dr. Dropkin has made the following summary of his results and conclusions:

1 The effect of radiation on the dry-bulb temperature is large

and must not be neglected if one expects to do accurate psychrometric work. The true temperature of the air can be computed from the equation

$$t_a = t - \frac{0.3105}{(V)^{0.56}}\left[\left(\frac{T_w}{100}\right)^4 - \left(\frac{T}{100}\right)^4\right]\left(\frac{D_2}{0.235}\right)^{0.44}$$

or

$$t_a = t - \frac{0.07272}{(G)^{0.56}}\left[\left(\frac{T_w}{100}\right)^4 - \left(\frac{T}{100}\right)^4\right]\left(\frac{D_2}{0.235}\right)^{0.44}$$

or

$$t_a = t - \frac{0.1087}{h}\left[\left(\frac{T_w}{100}\right)^4 - \left(\frac{T}{100}\right)^4\right]$$

in which

t_a = true temperature of the air, F
t = temperature of the thermometer bulb exposed to radiation, F
T_w = absolute temperature of the wall of the enclosure, F
T = absolute temperature of the thermometer bulb exposed to radiation, F
D_2 = diameter of the thermometer bulb, in.
V = air velocity, ft per min at barometric pressure of 29.92 in. of mercury and temperature of 70 F
G = weight velocity, lb per (min) (sq ft of cross section)
h = film coefficient, Btu per (hr) (sq ft) (deg F difference in temperature)

2 The coefficient of emissivity of the bulb of the mercury-glass thermometer, in the assumed range of temperatures, is 0.632.

3 The true wet-bulb temperature can be computed from equation

$$t' = t - \left(1 + \frac{h_r}{h_g}\right) \cdot \frac{(e' - e)(t - t_1')}{(e_1' - e)}$$

in which

t' = wet-bulb temperature shielded from radiation, F
t = dry-bulb temperature of the air-vapor mixture, F
h_r = coefficient of heat transfer by radiation, Btu per (hr) (sq ft) (deg F difference)
h_g = coefficient of heat transfer by convection, Btu per (hr) (sq ft) (deg F)
e' = vapor pressure corresponding to the wet-bulb temperature t', in. of mercury
e = partial vapor pressure in air-vapor mixture, in. of mercury
e_1' = vapor pressure at the exposed wet-bulb temperature, in. of mercury
t_1' = exposed wet-bulb temperature, F

4 The radiation error cannot be given as a percentage of the wet-bulb depression without stating the wet-bulb temperature.

Diesel-Engine Ignition Lag

SULZER TECHNICAL REVIEW

IGNITION lag is one of the most important stages of the combustion process in a Diesel engine, says H. H. Wolfer in a paper appearing in the *Sulzer Technical Review*, No. 3, 1939. As it can be determined so easily today, ignition lag has been adopted as a direct measure for the classification of a fuel. The tested fuel is characterized by the percentage of cetane in a mixture of cetane and alphamethylnaphthalin which has the same ignition lag under the same experimental conditions. The number of investigations of this phenomenon has greatly increased. An article describing the experiments carried out at The Pennsylvania State College appeared in this section in the November, 1939, issue of MECHANICAL ENGINEERING.

With increasing ignition lags the engine runs less smoothly until eventually knocking occurs. The accompanying phenomena are smoky exhaust, deposits on pistons as a consequence of incomplete combustion, and, particularly, dangerous stressing of the bearings. Other investigations have shown, however, that the ignition lag should not be allowed to fall below a

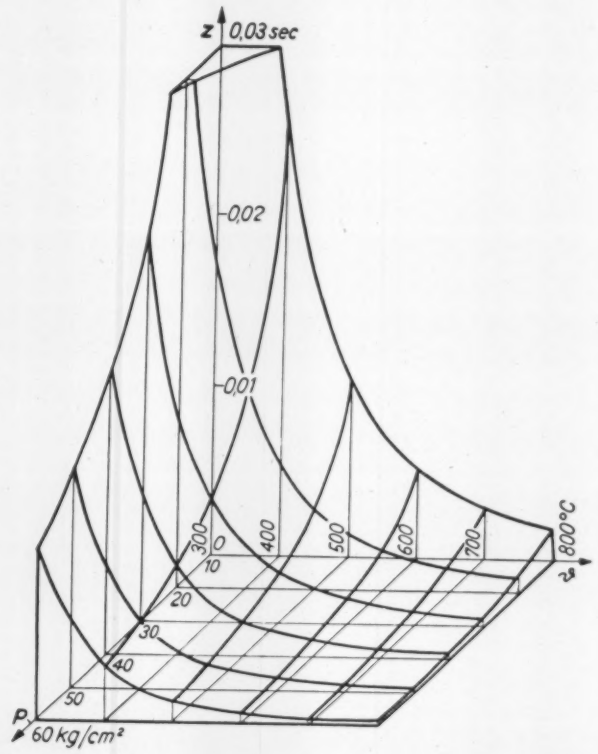


FIG. 1 IGNITION LAG τ AS A FUNCTION OF AIR PRESSURE AND OF AIR TEMPERATURE

certain minimum value. With a decreasing lag the time of combustion increases, thus causing increased heat losses in cooling water and exhaust. Early ignition may overheat and carbonize the nozzle; it may also prevent a good mixture of the fuel injected later with the air.

Consequently, according to Dr. Wolfer, the influence of various factors on the ignition lag is therefore of great importance. These factors were investigated by him in two experimental vessels and the results obtained were afterward confirmed through tests on a Diesel engine. These results show that the ignition lag is above all influenced by the temperature and pressure of the combustion air. It appears to be more or less independent of the following factors: (1) Excess air, whether it be varied by the quantity of air or the quantity of fuel; (2) the shape of the combustion chamber; (3) the shape of the fuel nozzle; (4) the injection pressure; (5) the swirling of the air; and (6) the temperature of the fuel, if it is not higher than 100 C.

The tests showed the difficulties in determining the temperature of the combustion air, especially in vessels where the air is heated by contact with the hot walls. The temperatures measured in those vessels are higher than the actual air temperatures. This explains why the ignition lag observed in tests made in closed vessels is greater than the ignition lag observed

in actual engines. It has been found that the ignition lag depends on the pressure and temperature of the air, according to the laws of chain reactions. This leads to the following conceptions of the initiation of the combustion.

The reaction begins at the moment when the fuel enters the combustion chamber. During a certain length of time the reaction velocity increases approximately isothermally, since the cold fuel that continues to enter and to evaporate prevents a rise of the temperature. Later the temperature slowly increases until a flame that appears in a small reaction center disturbs the thermal equilibrium and thus starts the ignition.

The results of the tests (see Fig. 1) lead to the following expression for ignition lag in Diesel engines

$$\tau = \frac{0.44}{p^{1.19}} \cdot e^{4650/T}$$

where τ = ignition lag in sec $\times 10^{-3}$, p = absolute pressure of the combustion air in atm, and T = absolute temperature of the combustion air in deg abs. It has been found that this formula is sufficiently accurate for all fuels with a cetane figure higher than 50.

Economics of New Equipment

1939 CHARLES T. MAIN AWARD CONTEST OF THE A.S.M.E.

ECONOMICS of investment in new equipment implies more than just a study of the dollars and cents results of purchasing new machinery, states James R. Bright, Junior A.S.M.E., in his paper, "The Economics of Investment in New Manufacturing Equipment—With Concrete Cases," which won the 1939 Charles T. Main Award of the A.S.M.E. while he was a student at Lehigh University. The author treats his subject on a broad basis including, with the discussion of "economical" investment, a consideration of the effect of an investment upon the equipment-building industry, upon industry's condition as a whole, and techniques and staff services which aid the executive in making his analysis. He shows how new equipment in the shop means replacement of old equipment which helps to reduce costs of maintenance, labor, waste in materials and space, power, and accidents, to improve the intangibles of quality and morale, and to increase capacity.

Finally, Mr. Bright comes to the conclusion that the economics of investment in new manufacturing equipment is a complex problem calling for a thorough study by the equipment purchaser. The main point to remember in making economy studies is that although every problem is unusual in some respect, the cost of producing equal annual quantities with each set of equipment must be the basis of the comparison. When the economy study involves investments which have already been made, the purchaser must compare only those costs which will be different if the change is made. It must be repeated that the most optimistic showing of an economy study can often be completely nullified by a careful consideration of judgment factors (intangibles which cannot be expressed in terms of dollars and cents).

Depreciation studies, contends the author, should, in general, be raised to be more in line with economic life rather than physical life. Over a period of years the accountant should allow for the effect of a change in the purchasing power of the dollar. Forecasting of the long-time trend will enable industry to build capacity on a steadier and more reliable base than the business cycle. It will also reduce costs and liabilities of failure due to overextended positions. By building up mortality curves for classes of physical property, the manufacturer can make better judgments of the reserves needed for replacement.

Much remains to be done. The manufacturer must be educated about the means of making a true economy study and about the advantages accruing to himself and to the equipment builder of buying equipment on a logical replacement policy. With the help of the economist and the statistician, as well as the accountant, there is some hope that industry may be freed from the necessity of standing or falling with the shaky business cycle.

Operation of the Futurama

ELECTRICAL ENGINEERING

THE magic carpet of story-book fame was brought to life at the 1939 New York World's Fair when General Motors took 5,000,000 visitors on a tour over a miniature cross section of America on a 600-seat spectator conveyer. The modern Sinbads saw mountains, valleys, and plains, cities, towns, and farming communities, rivers, lakes, and dams, and through it all ran the proposed superhighways of the future with their traffic-control towers, multidecked bridges, and separate lanes for speeds up to 100 mph. Appropriately named the "Futurama," the exhibit, which will be repeated in 1940, is said to be the largest scale model ever built, covering nearly 35,750 sq ft and extending for almost one third of a mile. Contained in it are about 500,000 buildings, more than 1,000,000 trees, and 50,000 scale model automobiles, 10,000 of which actually operate.

But, to engineers, the most remarkable feature of the whole exhibit is the specially designed and constructed conveyer consisting of a continuous train of moving cars almost one third of a mile long together with loudspeakers which provide each spectator with a running account of the changing scene throughout the tour. The description of the conveyer's construction and operation, which follows, is taken from an article written by James Dunlop and W. T. White and appearing in the December, 1939, issue of *Electrical Engineering*.

From Fig. 2 it may be seen that the conveyer is set up on an endless, circuitous track which has many radii varying from 9 to 98 ft with changing elevation reaching a maximum of 23 ft above the lowest point. There are spiral sections of the track having an incline of one on six with a radius of 18 ft. The total

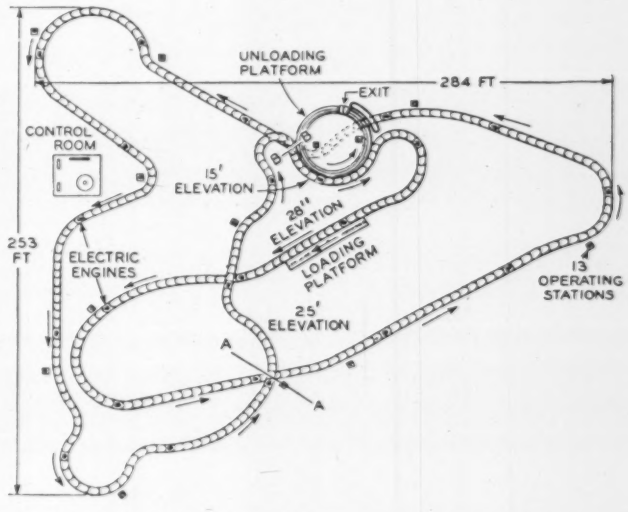


FIG. 2 PLAN DIAGRAM OF CONVEYER IN FUTURAMA EXHIBIT AT NEW YORK WORLD'S FAIR

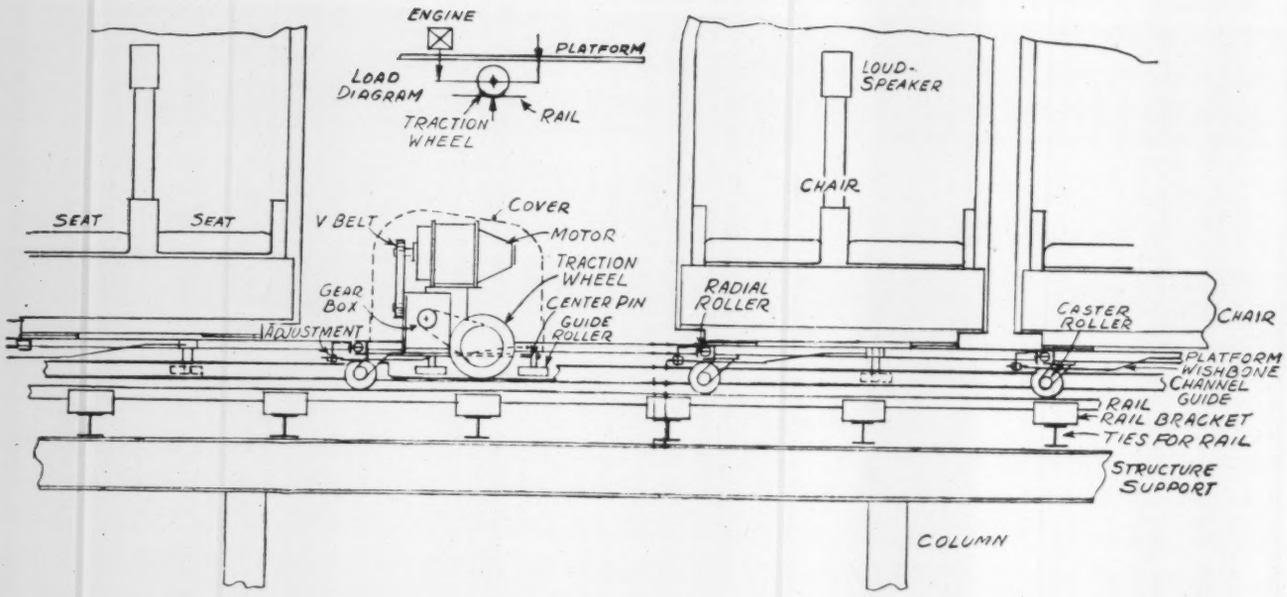


FIG. 3 SKETCH SHOWING DESIGN AND LOADING DIAGRAM OF CONVEYER "ENGINE" AND GENERAL ARRANGEMENT OF RUNNING GEAR

length of the track is 1568 ft. It consists of a channel-shaped center track which definitely fixes the path of the conveyer. The outer tracks are angle shapes having the flat surface horizontal to receive the wheels of the train. Referring to Fig. 3, these three tracks are shown to be mounted on a structural trestle which extends the entire path of the conveyer.

The conveyer consists of 322 platforms of sufficient width to carry a double chair and still leave ample passageway in front of the chairs. The length of the platform is about five ft, one end being made concave and the other convex. At the concave end immediately beneath the surface is provided a channel track upon which rest small Micarta rollers mounted on pins, set radially to the center pin in its mating platform. The center pin has a soft-tired roller mounted on it which runs within the channel-shaped center track. There is considerable warpage in the platform as it passes through the spiral track, but by having it supported on the tracks by only two wheels at one end and at the other end on wheels enclosed in the channel track of its mating platform, the surfaces of the platforms are kept flush with each other.

The platforms are connected, as shown in Fig. 4, by wishbone-shaped couplings designed to have rigidity in the horizontal direction only but to have flexibility in the vertical so as to accommodate themselves to the positions of the platforms at all times. Since this endless train of platforms must be made exactly the same length as the tracks, an adjustment can be made through the adjusting screws at the ends of the wishbones. One turn of the nut on the screw between each car and the next would represent a change in the total length of the train of 30 in. The problem of change of total length of the track measured in platform pitch due to the chordal action of the platform pitch passing round the many radii was solved by the arms of the wishbone being made slightly corrugated which permits of slight lengthening or shortening of the train.

To drive the conveyer, 23 "engines" are furnished, one on every fourteenth platform. Each engine consists of a 2-hp compound-wound electric motor driving a rubber-tired traction wheel through a V-belt, worm-gear reducer, and roller chain as shown in Fig. 3. This equipment is mounted on a sole plate which has one end attached to the center pin of the platform by a universal ball bearing. The other end has a roller fastened to it which lies in the horizontal position within the center guide track. The position of the rubber-tired traction driving wheel is exactly central between the roller on the center pin and the roller on the other end of the sole plate. In this way the traction roller is always in the theoretically correct position with respect to its travel throughout the entire path of the center track.

The load diagram at the top of Fig. 3 shows how the reaction of the weight of the engine and of the platforms is taken on the rubber-tired wheel, thus obtaining the necessary tractive force. Power is fed to the 23 engines through a trolley system underneath the platforms, and the connection is made to each motor through a carbon-brush system which slides along the surface of the trolley wires. These trolley wires are made of an H-section, having a smooth, flat surface on top. The control is of the variable-voltage type, power being supplied by a motor generator set.

Concealed in the center arm of each double chair is a loud-

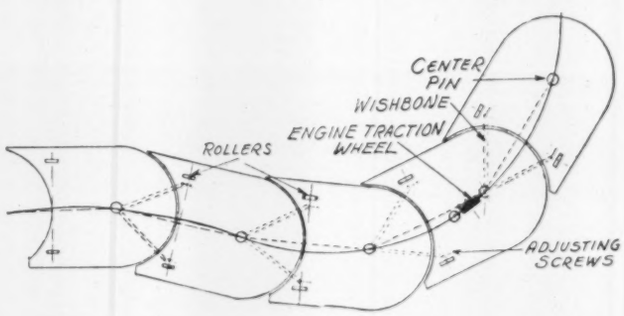


FIG. 4 SKETCH OF CONVEYER PLATFORMS SHOWING METHOD OF COUPLING THE CARS TOGETHER

speaker through which the two occupants of that chair listen to a descriptive talk about the portion of the exhibit before them. The description of the exhibit is recorded on over 600 ft of sound film wound in 24 bands on a huge steel drum which rotates in synchronism with the spectator conveyer. The sound is picked up from this film by 150 photoelectric tubes, the tubes being connected through amplifiers to a system of

trolley wires around the track and from these through contact shoes to the loudspeakers in the chairs. By this means each passenger is assured a description of the scene before him, which may be different from that seen by the passengers a few feet in front or behind him. The acoustical design of the chairs prevents interference between loudspeakers in adjacent cars.

Pneumatic Tires for Rail Cars

THE BROWN BOVERI REVIEW

OF INTEREST to mechanical engineers in the French Pavilion at the New York World's Fair in 1939 was the "Micheline" electric rail train on pneumatic tires. In the September, 1939, issue of *The Brown Boveri Review* appears an article that gives some details of this train, including the construction and operation of the wheels and tires. A brief description of the latter, which follows, has been abstracted from the article.

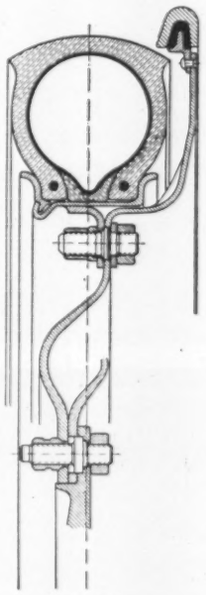


FIG. 5 MICHELINE RAIL WHEEL WITH PNEUMATIC TIRE

As shown in Fig. 5, the rubber tire inflated to a pressure of 128 psi is mounted on a rim similar to those used on heavy motor trucks. The flange of steel is fitted in a rubber lining in order to suppress any transmission of noise from rim to wheel proper and thence to the coach. However, in the latest type of rail train, the running wheels of the truck have flanges while the driving wheels have none. The dimensions of the running-wheel pneumatic tires are 49 × 240 in. and of the driving-wheel tires 59 × 342½ in. Inside of each tire is a cushion which is provided so that if air escapes or if a tire blows out, the tire rim will be kept off the rail. Signal lamps warn the motorman in his cab if the air pressure in any tire is too low. It is possible to run at reduced speed with a defective tire to the next station where the flat tire can be replaced by a spare, just as in an automobile.

The loading capacity of the tire, which was 1400 lb in 1933, is now 2700 lb. In the same period, the average life of tires has been doubled, it now being 22,000 mi. With only one third the weight of ordinary railway coaches, the Micheline rail train can attain a speed of 80 mph.

European Industry and the War

FACTORY MANAGEMENT AND MAINTENANCE

INDUSTRY in Great Britain and France has undergone great changes since the war began in the first days of September, 1939. The governments of the two democratic nations have been forced to adopt the totalitarian methods of their common enemy in their dealings with industries, which has already led to the control of labor, materials, prices and profits, transport, and imports and exports. Because of the great interest shown on this side of the Atlantic by engineers and factory executives in this phase of war, *Factory Management and Maintenance* has published in its December, 1939 issue, an article by Ursel Baliol Scott, secretary of the British Management Council, on "British Industry and the War," and in its January, 1940 issue, one by R. P. Schwarz on "French Industry and the War." A condensed version of the two articles follows.

In reviewing the effects upon British industry of the first seven weeks of the war, Mr. Scott has done so almost entirely in terms of the legislative and executive acts of the government. Never before in history have so many far-reaching restrictions been imposed upon free enterprise in so short a time and with such lack of opposition. However, British industry can be relied on willingly to submit to yet more rigid control so long as it can be seen to be achieving a useful purpose and so long as it is confidently believed that the control will be relaxed after the war as readily as it has now been imposed. The government has, in fact, imposed restrictions and controls upon the normal functioning of industry at so many points that production programs are deeply affected by this action. None can doubt that ultimate responsibility for wartime production rests with the government, and that in effect British industry has for the time being become nationalized (except when it comes to paying the bill, for which purpose industry remains on a private-enterprise basis).

The attitude of organized labor in Britain has been highly cooperative, and in this respect parallels the experiences of the World War. While the outbreak of the present war has produced acute short-term dislocation of labor and consequent hardship, this condition is overshadowed by the long-term problem which will, given a prolonged war, be precisely the reverse—one of shortage of labor. Although under the National Service Act all able-bodied men between the years of 18 and 41 (except clergy and conscientious objectors) are liable to military service, the mistake of mobilizing the workers in key industries has not been repeated, and a long schedule of reserved occupations, erring if anything on the side of comprehensiveness, has been compiled. Furthermore, a Control of Employment Bill may be made applicable at the discretion of the Minister of Labor to insure the best use of man-power by preventing the poaching of key workers. The machinery for collective bargaining remains largely unchanged, with the Ministry of Labor occupying its traditional role of lubricant between employers and unions.

The British government is endeavoring where possible to insure that raw materials are readily available to factories manufacturing for the military services and for export. In regard to the latter, this is being done in order to offset inflated war imports and to hold customer good will pending a return to peacetime trading. With the introduction of rationing over a wide range of raw materials and foodstuffs, it has proved possible to fix and maintain, subject to periodic alteration, maximum prices for these commodities. Due, however, in part to rising costs, and in part to the government's plan for compulsory war-risk insurance, and in part to incipient profiteering, the general trend of prices has been upward, and the rise in the cost of living since the outbreak of war is already being put as high as 10 per cent. War-risk insurance of goods for sale has been made compulsory where their value exceeds $4000, the risk being carried by the Board of Trade at six per cent. Some firms have taken this as an excuse to raise prices far in excess of the amount necessary to cover the premium. Mainly as a result of this type of profiteering, active steps are now being taken to penalize the entrepreneur who derives unfair profit from the national emergency.

In France, according to Mr. Schwarz, state encroachment on national economy is definitely on the increase, which is not very astonishing since this war is dominated by economic as well as by purely military factors (if not more so). To beat totalitarians at the totalitarian war game requires, unfortu-

nately, totalitarian methods. But the difference lies in the spirit in which these methods are enforced. In Germany, need is turned into virtue. In France, no attempt is made to extol these methods or to deny their unpleasantness.

Under the Reynaud three-year program of November, 1938, the 45-hour week was substituted in practice for the 40-hour week, and overtime facilities were greatly increased by removing red tape in connection with overtime permits. Since Sept. 6, the 60-hour working week has become legal, with a daily maximum of 11 hours (reduced to 10 in the case of women and children). In the defense industries (continuous-operation plants), the maximum working week has even been lengthened to 72 hours.

Wartime production requirements have been discounted to a considerable extent by "mobilization on the spot" of workers, notably specialists and engineering or managing staffs—a procedure in many respects comparable to the British system. Such mobilization on the spot has been granted in the first place to establishments that have either been (*a*) commandeered outright for direct operation by the defense industries (war, air, and marine) or the food services, or (*b*) requisitioned under amicable agreements by these same departments. In the latter case, operation continues mostly under civilian management subject to supervision by the control officers of the requisitioning authorities.

When the state requisitions a business wholly or in part for direct operation, indemnity granted is composed of three elements: (1) Interest paid on physical assets as determined by an inventory as of the day of requisitioning, such interest being payable at one per cent above current bank rate; (2) an allowance for normal industrial depreciation which is payable at the end of the requisitioning period only; and (3) if necessary, compensation for the difference between initial inventory value of requisitioned assets less normal industrial depreciation, and actual inventory value at the end of the requisitioning. Interest allowed may never be higher than average industrial profit taxed during the three years preceding requisition.

In the case of the so-called amicable agreements, wartime supply of materials, products, or services in the interest of the nation is in principle exclusive of any entrepreneur profit. These supplies allow only for remuneration of capital invested. Since it would be difficult to assess such capital in each case, this purpose is achieved indirectly and by gross approximation by limiting profits in relation to defense turnover. The maximum profit possible under this plan is four per cent. What net profit remains after the limitation plan has been applied is then further subject to normal business taxes, notably industrial and commercial profits tax (16 per cent at present) and exceptional national contribution (two per cent in 1939; four per cent in 1940).

The preceding remarks relative to costing and taxation refer to industries working "in the interests of the nation." But the limitation of profit plan is now being extended to all industries and commercial establishments. The scale of limitation and details of application are not yet known except in so far as export business will be expressly excluded from such limitation.

One result of the war situation has been to make it compulsory for a number of French industries to hire workers through public labor exchanges and to notify the exchanges immediately of any discharge occurring among their personnel. These rules cover practically all mechanical trades in the metal and metal-working industries, the chemical industries, and various lines of workers employed by the electrical and optical industries. Already for some time prior to hostilities, shortage of skilled workers, notably in the mechanical trades, had led to systematic retraining of unemployed workers, partly by the employer, partly by union initiative, and with the assistance of public funds. Some satisfactory results were accomplished, but the low appropriations available limited the scope of such endeavors. At present the Ministry of Labor is taking steps to cooperate with the Ministry of Education in the control of professional training schools. Concurrently, it is relaxing restrictions formerly placed on employment of foreigners by abolishing quotas applicable to them in given industries and trades.

Employer-employee relations, already much improved since the abortive general strike of November, 1938, are now governed by a wartime truce. Hourly wage rates have been reduced indirectly through the lengthening of the legal working week from a former 40 to the present 45 hours at equal pay to the worker. Overtime wage payments have been completely abolished except for night work, and overtime hours are paid at normal wage rates. Moreover, overtime remuneration for hours worked in excess of 45 per week are taxed by deduction at source to the extent of one third, and the money so collected contributed to the National Solidarity Fund which pays allowances to the families of mobilized soldiers and pensions to war invalids. Furthermore, the employer is required to pay into the fund the difference which is accruing to him as a result of the lengthening of the legal working week from 40 to 45 hours.

The price level has so far remained stable. The inflationary effects of the war have not yet made themselves felt. A strict price control aims at stabilizing all prices at the Sept. 1 level, and this applies not only to goods sold but also to services rendered by industrial or commercial establishments. Exceptions will eventually have to be granted, notably for imported products, on account of exchange fluctuations. But all changes in quotations must first be approved by price-control committees.

Little information is available on developments in industrial plants; and even if it could be obtained, it could not be published, for defense reasons. Development of straight-line production has been noticeable for some time prior to the war and most conspicuously so in the aircraft industry, where wholesale improvement in machine-tool equipment has been pursued vigorously since early in 1938 and has now placed the industry on a mass-production basis. However, it is doubtful whether, pressure of circumstances apart, much will be done fundamentally to change internal industrial organization. It may be that in the course of the war some new investment in capital goods will develop from industrial decentralization. If air raids were to lead to a fall in production figures, such decentralization, already fostered prior to the war, may become a task of the first importance.

Aeronautic Research in 1939

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

THE twenty-fifth annual report of the National Advisory Committee for Aeronautics was presented to Congress on Jan. 8, 1940, by the chairman of the committee, Vannevar Bush, member A.S.M.E. According to the report, the most significant event of 1939, in its relation to the future of American aeronautics, was the authorization of a second major aeronautical-research station for the committee. The site finally selected by the committee under authority of an Act of Congress is Moffett Field, Calif., located about 38 miles south of San Francisco. This additional laboratory will serve to relieve the present congestion of work at the committee's Langley Field laboratory in Virginia and will provide new research facilities necessary to enable the committee to provide more effectively

for an enlarged volume of research work to support and accelerate the technical development of American aircraft.

During the last year important progress was made in many ways in providing, through the committee's researches at Langley Field, new knowledge which should be the basis of extensive improvements in American aeronautics. Discovery during the last year of a new principle in airplane-wing design may prove of great importance. The transition from laminar to turbulent air flow over a wing was so delayed as to reduce the profile drag, or basic air resistance, by approximately two thirds. It is too early to appraise adequately the significance of this achievement. So far, its application is limited to small airplanes, but there are indications of its ultimate applicability to larger airplanes through continued research. It should increase the range and greatly improve the economy of airplane operation.

To coordinate the research needs of aviation, civil and military, and to prepare programs of research in the various branches of science affecting aeronautics, the committee has established four major standing technical subcommittees, on aerodynamics, power plants for aircraft, materials for aircraft, and aircraft structures. There are also other special and subordinate subcommittees. The main Committee, upon recommendations of subcommittees or upon its own initiative, authorizes research programs in its own laboratories or by contractual relations with independent laboratories. Because of the increasing relative importance of aeronautics in national defense and in transportation, the committee believes that the needs of the country justify a further immediate expansion of research activities in two directions, namely, the establishment of an engine-research laboratory, and additional stimulation of aeronautical research in educational and scientific institutions.

Quite as important as laboratories for any aeronautical research is the adoption of a farsighted policy to develop trained technical personnel. The committee believes that the stimulation of aeronautical research in scientific and educational institutions, as proposed, is the most effective and, incidentally, the most economical way to develop in larger numbers and in a democratic manner the talented individuals having the scientific training necessary to engage successfully in what has become an international competition.

Air-Raid Precautions

VARIOUS SOURCES

WAR in its modern version knows no bounds and respects not even the lowliest creature situated in cities far from the fighting front, due mainly to airplanes with their power to attack by impact, poison, fire, and explosion. Of course, these attacks may be prevented to some extent by military methods but it is clear that no countermeasures can be entirely effective. Consequently, engineers in Europe and Great Britain are now faced with the additional problem of minimizing the effects of destruction of aerial bombs upon homes, machinery, plants, and personnel.

EFFECTS OF AERIAL BOMBS

Before describing the several methods and plans developed in European countries, especially England, for the protection of general human activities from the aerial bomb, a brief review of the forces exerted by the various types of bombs and of such consequences of these forces as collapse and fire will be presented. An article on high-explosive bombs appeared in this section in the October, 1939, issue of MECHANICAL ENGINEERING. Other articles on the subject have been published by contemporary technical journals and papers presented. One such paper, given by Herbert Chatley and Hal Gutteridge before the Society of Engineers of London and published in full in *The Engineer* for Nov. 11, 1938, contains some useful figures regarding the energy released by these bombs upon impact. The authors find that a 20-lb bomb traveling at a velocity of 1000 ft per sec has an initial impact force of over 500 tons, if stopped within a distance of 1 ft. In addition, the result of the impact is to convert the whole of the explosive into gas with a heat content of 1260 Btu per lb.

Bombs containing 10 lb of explosive, occupying 0.1 cu ft, tend to produce 1000 cu ft of gas at a momentary pressure of 70 tons per sq in. The effective velocity of the gas corresponding to its heat energy is some 8000 ft per sec, so that fragments of the bomb may acquire velocities comparable with those of rifle bullets (nearly 3000 ft per sec) and cause great impact effects. An incendiary bomb, either thermit, magnesium, or oil, will release from 900 calories to 10,000 calories per gram of contents.

As regards the resistance of ordinary structures to these forces, it is said that existing arrangements give little or no protection, except to low-placed interior rooms in a high building with strong roof, floors, and walls. To increase the resistance to destruction it is suggested that all new buildings be wholly of fire-resistant materials. To resist the effects of concussion, the walls, as well as the floors, should be designed to resist large overturning movements and side shears, as gas pressures of 500 lb per sq ft might easily occur. The walls below first-floor level should be specially designed to resist splinters. However, the improvement of old structures in fire resistance and strength is difficult. Probably, the best and most economic step is to install a sprinkler system on every floor and reduce the inflammable furniture to a minimum. Additional pillars and metal wall and roof ties should be put in where possible, and plaster ceilings should be replaced by material that would not fall in lumps.

As to machines, the heaviest types, if well bolted to their bases, are more likely to be damaged by falling parts of buildings or by the collapse of a supporting floor than by direct gas pressure. The danger of destruction by inertial effects of sudden stoppage is greater, to say nothing of the hazards of damage to boilers and pipes, with the escape of steam, gas, or oil, which may cause incidental fire or explosion.

TECHNICAL INSTITUTIONS

Pressed by the necessities of war, technical institutions in Great Britain have been forced to be less active in forwarding the interests of those spheres of engineering which are their particular and individual concerns than in striving to aid the government and their own members to carry out work of urgent national importance. The more immediately apparent effect of the war upon the activities of the institutions, according to an editorial in *The Engineer* for Dec. 1, 1939, is that of interfering with their meetings. In the belief that during the first weeks of the war London and other large centers would be the subject of severe and frequent aerial attack, the majority of the institutions decided at once to cancel all meetings, social or otherwise, and to rely upon their publications to keep them in touch with members. Since that time, and despite the absence of aerial attack, the severity of the evening "black-out," the transfer in some instances of office staffs to country quarters, doubts as to the number of members likely to be attracted, and other factors have influenced the institutions to hold at least temporarily to their original decisions. Signs are not wanting, however, that some at least may soon relax the severity of the ban. In the provinces the ban on meetings has been less complete, and all varieties of arrangements can be found, from total abandon-

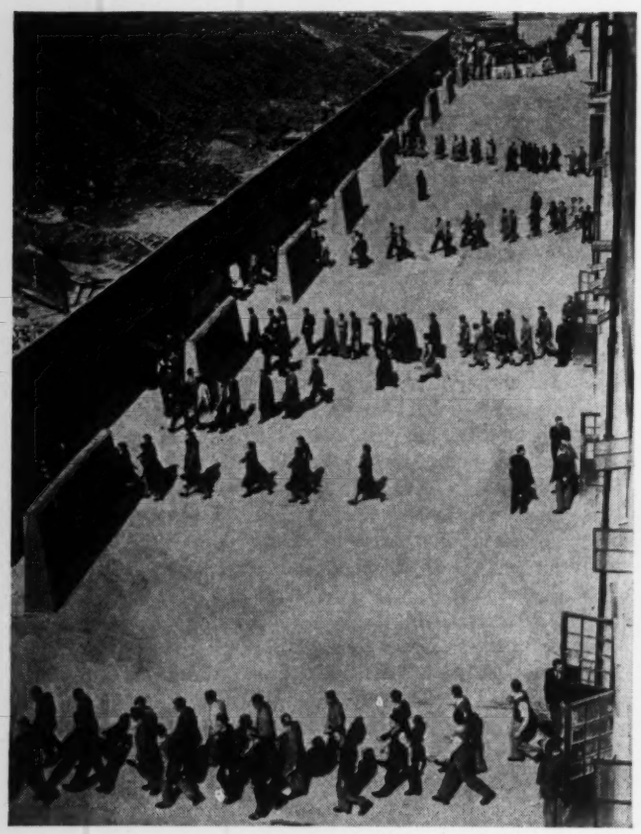


FIG. 6 AN INDUSTRIAL UNDERGROUND SHELTER IN LONDON, ENGLAND

(The picture shows an air-raid drill in progress during which 6000 workers evacuate the plant in $7\frac{1}{2}$ minutes and move in orderly fashion into the underground shelters.)

ment to the holding of the complete programs as arranged before the outbreak of the war. The Institution of Engineers and Shipbuilders in Scotland, for instance, whose headquarters are located in Glasgow, is holding evening meetings once a month, and has made the sole concession to the black-out that dates are chosen which fall at periods near full moon.

RULES AND REGULATIONS

In Great Britain, the necessity of civilian defense against air raids was realized, and planning was commenced by the government, three years ago. The resulting civil defense organization, decentralized as far as possible, but coordinated under the Minister of Civil Defense, directs the activities of some 2,000,000 men and women who have volunteered their services in various capacities. The purpose of this system of "Air Raid Precautions," commonly referred to as "A.R.P.," is the maintenance of the life of the country in face of every attempt of the enemy to disorganize it. Control of A.R.P. activities is organized regionally and locally. The discussion which follows is based on an article appearing in the November, 1939, issue of *The Engineering Journal* of the Engineering Institute of Canada.

The cost of the whole A.R.P. organization, central and local, is estimated at more than $300,000,000 for this year, about 10 per cent of this falling upon local authorities. Activities connected with A.R.P. may be classed under eight heads, as follows: (*a*) Protection, i.e., defense and shelter against aerial attack by bombs; (*b*) evacuation, the removal from London and other cities of children of school or preschool age, expectant mothers, adult blind, and cripples, totaling some 4,000,000 persons; (*c*) casualty services, providing for first aid and hospitalization for 300,000 civilian casualties which might occur in a week of heavy raiding; (*d*) fire fighting, to control as far as is possible the fires resulting from incendiary bombs with the aid of the regular fire brigades and an auxiliary fire service consisting of a force of 250,000 men; (*e*) antigas measures, including the provision of gas masks and refuge rooms for civilians; (*f*) lighting restrictions (black-out), particularly as regards railways, street lighting, factories, private houses, and automobiles; (*g*) public warnings of the imminence of an air raid, or the departure of raiders; and (*h*) food defense, dealing with the provision, distribution, and sale of food.

AIR-RAID SHELTERS

Defense against bombs under A.R.P. consists mainly of providing shelters for the populace. Since general protection against direct hits would be too expensive and would take too long to construct to be practical, only shelter against the "blast" or shock wave in the air caused by the explosion and against splinters from the bomb case is being provided to a reasonable extent. Size of individual shelters is being limited to a maximum capacity of 50 people. Shelter at home is being provided by "garden steel shelters" (of which about 2,500,000 are being distributed) or, by "domestic surface shelters" consisting of concrete or brick huts, for which standard designs are available, or by reinforcing suitable basements and cellars in houses up to three stories, or finally by "communal shelters" for people who have neither basements or gardens. So far these five shelter systems are being provided only for persons within the $1000-a-year income limit, who are roughly estimated at 20,000,000 in number. Private persons above the $1000 limit, are expected to provide their own shelters.

The government is arranging for special types of heavily protected shelters for factories where steady maintenance of production is vital in wartime. All employers who have more than 50 workers have to provide shelters and may receive financial assistance from the British treasury for this purpose. An industrial underground shelter is shown in Fig. 6.

BLACK-OUT

London, Paris, and Berlin, and indeed all large centers in the warring countries, are subject to drastic regulations, looking to the complete abolition of lights visible from the air during periods of darkness. The official requirements in Britain include the use of opaque blinds and curtains to mask all windows, skylights, and doors in private houses as well as in business premises and industrial buildings, the restriction of lighting in automobiles, busses, railway trains, and stations, the extinguishing of street lighting, and the lights along waterways. The lighting order now in force in Great Britain prohibits the emission from the premises of all direct or reflected light of whatever color. Under these conditions, movement in the streets naturally involves considerable risk, as is already proved by the rise in street fatalities at night since the beginning of the war. Traffic lights, where permitted, are screened by disks in which a small X-shaped opening is made. Motorcars have a special metal hood or mask with small slits fitted to the right-hand head lamp, while the head lamp nearest the curb is removed.

However effective the arrangements made to insure the blacking-out of lights of a building there is always the danger that a door may be inadvertently opened while a bright light burns inside. For doors through which there is a continuous stream of traffic the cost of the necessary light traps would be justified, but in many instances in offices, shops, and houses a cheaper device, which consists of an automatic switch above the door, is used. With this switch, the light is immediately

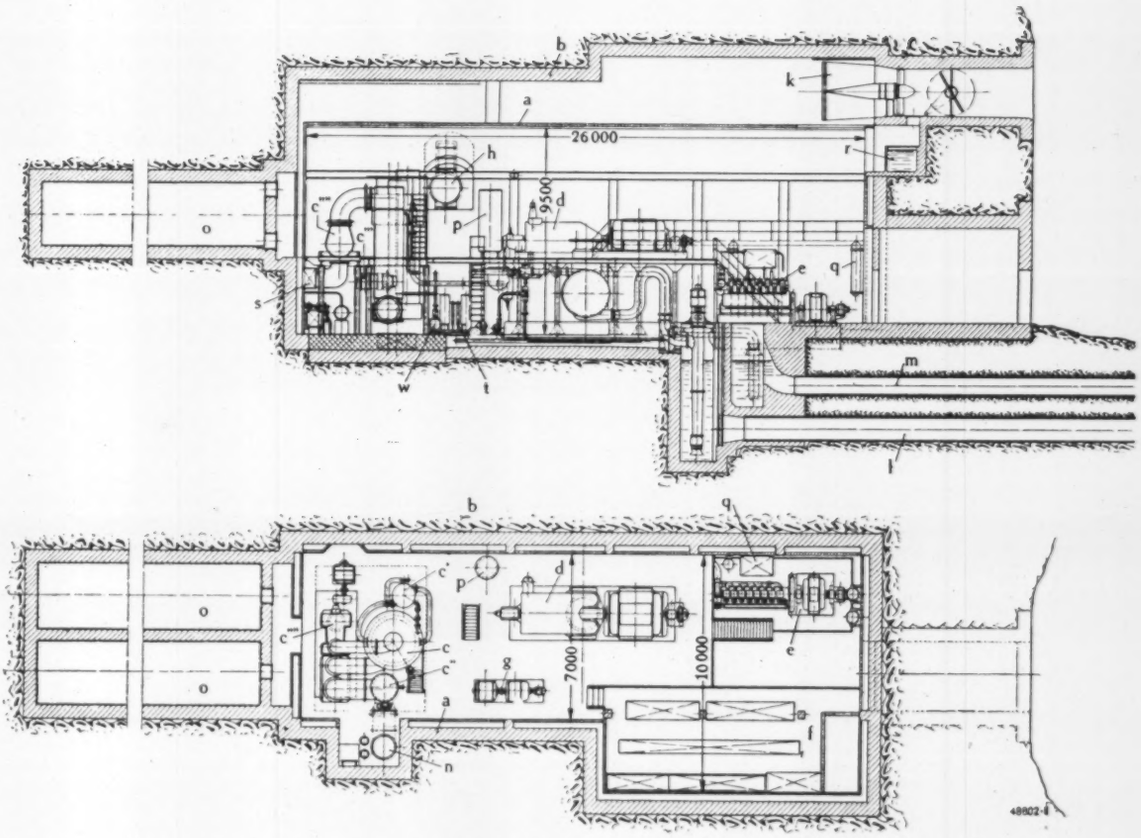


FIG. 7 AN UNDERGROUND BOMBPROOF STEAM-POWER 9400-KW STATION IN BERNE, SWITZERLAND

(*a* Inner lining of tunnel; *b* masonry work of tunnel; *c* Velox steam generator with water-steam separator *c'*, an economizer heated by exhaust gases *c''*, and charging set *c'''*; *d* turbogenerator set and condensing plant; *e* Diesel-operated set for starting the plant; *f* switchgear; *g* Ward-Leonard controller; *h* feedwater tank; *k* ventilating fan; *l* channel for cooling-water intake; *m* overflow and outlet channel; *n* exhaust-gas pipe; *o* main fuel tank; *p* auxiliary fuel tank; *q* tank for Diesel-engine fuel; *r* tank for cooling water of Diesel engine; *s* combustion air for Velox steam generator; *t* preheater of fuel with filter; and *w* feedwater pump.)

switched off as the door is opened and switched on as it is closed.

In *Canadian Metals and Metallurgical Industries* for October, 1939, full instructions are given on how to black-out a cupola furnace. The amount and type of screening required to protect cupolas working after dark will depend to some extent on the size, design, and location of the furnace. For cupolas out of doors, screening must be provided over the tapping and slag spouts and over the molten metal. The screening necessary will vary greatly, but it must be such that no direct light can escape from the "drop" at the end of the melt, from the tuyères, or from the charging hole. Where a cupola is situated within a building, it is probable that the general A.R.P. measures taken in the building itself, such as the darkening of roof lights and windows and provision of light traps at the entrances will make unnecessary separate screening of the furnace. The top of the cupola presents what is perhaps the most difficult problem, and it must be covered in such a way that no glare, flames, or sparks are visible when the furnace is operated after dark, even at the end of the blowing down period, when large quantities of flame are produced. Generally, a cowl must be fitted which completely covers the top of the stack and projects for some distance over the sides. The simple cowl is not suitable for a furnace with a short stack or where flames show above the top of the chimney at any stage of the melt. For cupolas with a short stack or for normal cupolas not already equipped with a spark arrester, an extension should be attached to the top of the existing stack, and this should be fitted with a baffle plate and a cowl arranged to cover the top of the stack extension.

Perhaps no problem has caused so much concern to those responsible for safeguarding a country's electricity supplies in time of war as lighting in generating stations, says R. H. Finch in an article appearing in the *Electrical Review*, Aug. 25, 1939. Almost any ordinary industrial plant could shut down during an air raid, but generating stations must carry on, and while work in these circumstances would obviously be kept down to the bare minimum, certain operatives would have not only to attend to the running of the plant, but also to the carrying out of complicated switching operations to cope with damage to mains and feeders, and might even have to start up or shut down machines or boilers if their own station is damaged. In new stations being built in Europe today, all factors in reference to air raids are considered. Fig. 7, for example, shows a 9400-kw bombproof steam power plant at Berne, Switzerland. But in old established power plants, no ordinary system of lighting or even an emergency system could be expected to operate in case of damage. Some other method must be provided. Mr. Finch suggests the use of ultraviolet or "black" light as it is sometimes called. The output of a "black" lamp can be reflected and redirected in exactly the same way as visible light. The whole station could be bathed in ultraviolet rays and light produced only where needed (such as on the handles of switches, meter scales, push buttons, telephones, doors, keyholes, tables, desks, stairs, and fire extinguishers) by the application to them of a dab of fluorescent paint or dye. On the floor in front of every switchboard should be painted a line 12 to 18 in. away. This line should be brought into the board at each side of every opening or door giving access to the back of

the board, and a line should be painted round the edges of each door. The treatment of switchgear is greatly helped by the natural fluorescence of common vaseline. This gives a clear indication of the presence and position of knife switches and other live metal on the face of the board.

In the turbine and boiler rooms, the maximum use should be made of fluorescent floor lines to indicate clear passages around and between the machinery, and written direction notices and arrows may be painted on the floor. Railings around pits and staircases can be indicated, either by fluorescent paint or by entwining around them a fluorescent plastic which is available in string form. The general shape and all projecting portions of any piece of machinery should be indicated by dabs or thin lines of paint, any exposed hot surface being shown by thin diagonal red lines.

SUBWAY PROTECTION

In conjunction with the British Ministry of Transport, the management of the London subways undertook an extensive program of emergency works in order to protect its services from any possible risks which might arise from air raids. According to an article in *The Railway Gazette* for Oct. 13, 1939, the cost of this program, much of which had been completed before the outbreak of the war, will be about $4,500,000. One problem of some magnitude is the protection of the underground railways from any possible risk of flooding, either from the Thames River or from the sewers or water mains, where they are in close proximity to the stations.

One method of protection adopted is the installation of electrically operated floodgates at certain of the stations and at the ends of the river tunnels. These gates are designed to resist a pressure of 800 tons, and each is built up of steel with an over-all thickness of 13 in. and weighs just under six tons. They are set in a framework of cast iron against the head wall of the station platform, alongside the tunnel mouth, as shown in Fig. 3. Under either electric or hand power the gates slide along the framework guides into position across the tunnel mouth. Electrical operation is controlled by push button and alternative supplies of power are available. Within three minutes of receiving orders to close, the gates can be run into the shut position and sealed. The actual closing of the gate across the tunnel mouth by power operation takes one minute, and by hand four minutes. Of course, the gates are only closed when the operators have satisfied themselves by means of illuminated track diagrams that all trains have cleared the sections of the line between the gates; the maximum time for a train to clear would be two minutes. Furthermore, interlocking devices are provided for the underriver sections of the subway which would prevent the gates from being closed while there is a train in the section. Just before the gates are closed, the operators fill in the gaps in the gate sill which provide spaces for the rails, so that a continuous runway is provided across the tunnel mouth over which the floodgates can slide into position. This is done by the operators fitting special metal sealing blocks with rubber linings into the gaps.

FIG. 8 VIEW OF SPECIAL FLOODGATE INSTALLED IN THE LONDON SUBWAY

(The floodgate is partly open, showing sealing blocks with rubber linings around running rails and workmen opening escape hatch.)

NOTICE

WAR EMERGENCY

On receipt of an Air Raid Warning passengers should note the following instructions:–

1. **trains will stop at the next station in order that passengers who desire may alight and seek the nearest public shelter;**
2. **trains will then proceed; the remaining passengers should close all windows and ventilators and pull down blinds where these are available.**

Should a train pass through a district which has received an air raid warning the outside of the carriages may have become contaminated by blister gas. Passengers should therefore note:–

1. **when alighting care should be taken to avoid touching any part of the exterior of the carriage;**
2. **the doors of trains composed of compartment carriages should be opened by the handle inside the door.**

At 19 of the subway system's stations, the engineers were faced with additional problems, such as the proximity of sewers and water mains which would flood the stations if damaged in an air raid. For example, at King's Cross station, it was necessary to block up some of the passageways from station to tubes with bulkheads of solid concrete between 5 and 6 ft thick. However, three of these bulkheads have already been removed and are now being replaced with manually operated steel bulkhead doors.

Multifuel Engines

CORRECTION

ATTENTION of readers is called to an error which occurred in the article on Multifuel Engines, which appeared in this section of the December, 1939, issue of MECHANICAL ENGINEERING. The cuts above the captions for Figs. 5 and 6 on pages 923 and 924 were reversed; the engine shown in Fig. 5 is the Fiat-Boghetto type and the one in Fig. 6 the Waukesha-Hesselman type.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Unionization of Engineers[1]

To the Editor:

I have just finished reading "Unionization of Engineers" as offered by James H. Herron in your November issue of Mechanical Engineering.

I note from the head of this article that this is one man's views offered in the hope of stimulating discussion.

I do not intend to enter into any lengthy discussion of this matter, but I do wish to send you the paragraph out of this article which I feel states my sentiments with regard to the title. It reads:

"Engineers and labor unions, in my opinion, have so little in common that unionization of engineers is at least an unnatural development." When it becomes necessary to unionize a group of men who are supposed to be better equipped to meet the world due to their college educations, it seems to me that we are taking them out of the category of persons who are able to take care of themselves. Unionization is supposed to be for people who are unable to take care of their own needs. It's a fine engineer who can't do this!

Harry W. Snyder.[2]

To the Editor:

There are three major reasons why my views on the subject of labor relations cannot be given the same full faith and credit that are due Mr. Herron's paper, namely

(1) Among my treasured possessions are a stamped dues card of Local No. 1, dated near the end of last century and a later union withdrawal or demit card, both tending to remind me of that great man who taught the truth of the paradox which was his slogan: "Whether you work by the piece or the day, decreasing the hours increases the pay." Each day in passing his statue on my way from Chevy Chase to and from my office in Washington, I glance with affectionate reverence at the large bronze figure of Samuel Gompers, who successfully led our local through its strike for a twelve-hour day.

(2) In more recent years, as adviser to different manufacturers faced with strikes which seemed directed either from Moscow or by Mephistopheles, I have seriously advised fighting that gentleman with fire, urging against compromise on demands having no reasonable basis, specifically, (*a*) that the business agent or walking delegate should alone have the arbitrary power to select which of our employees should be discharged without regard to seniority when it became necessary to lower our force by fifty men; (*b*) that all employees have their pay increased by 22 per cent when our manufacturing profits for that year was about 7 per cent, the ground being that the company which was closely family-owned had made profits of 22 per cent on an advantageous stock-market deal; and (*c*) that we must increase our pay by a flat 8 per cent because our nearest rival had raised his pay roll by that amount and our product could so easily be damaged; although our rate of pay in every department was already far above the average, while with the 8 per cent raise that of our rival was still well below the average.

(3) In spite of every endeavor on my part, the passing years and the graying of my thinning locks have not brought that mellowing by age which has graced many of my colleagues in both patent law and engineering. In fact, no better than Carter Glass have I been able to follow the legal suggestion, "When I was young and had no sense, I quickly used to take offense. Now I'm old and grown more wise, I just get mad at little guys." This section seeks to warn that my opposition to some of the heads of the C.I.O., their aims, objectives, and methods, is so great that I may not fairly be able to evaluate the relative advantages and harms of vertical unionization.

In a given case it might be simple to advise some particular young engineering technician whether or not to join the union that was seeking to organize his fellows. The problem, however, has no general solution, for there are opposing factors which in turn are varied by other factors that may not seem to be involved in the problem.

In many industries where there is a readily appreciated difference between the goods of rival manufacturers and, with such variances, a reasonable range of retail price, it has been possible for employer and employee to work out together a cooperative arrangement which is perfectly satisfactory to all concerned, as, for example, the Endicott Johnson Corporation scheme.

But there are cases in which no amount of understanding between a small company and its employees can bring satisfaction. For example, a coal-mine owner is paying less than a decent living wage but is making such a small profit in the business because of competition that to increase wages would replace the blue ink with that of carmine hue. Public indifference, apathy, and self-interest is such that if most of the operators agreed to raise wages and with it the price of the coal, the business would largely go to those who kept the old scale and price. Here a great union can and does cut the Gordian knot because it compels *all* of the operators to pay the living-wage scale, even granting that usually we must shut our eyes to the method, because the public interest as a whole is best served by getting the pay increase indirectly yet surely from the pockets of the ultimate consumer which in my own opinion is the proper source.

On the other hand, when by looking the other way at the correct time, we grant a union the right to compel the paying of higher wages where those wages are proper from every humanitarian standpoint, we give the opportunity to use the same tactics to gain advantages wholly contrary to the general good.

Were all labor leaders of the types of Gompers, Fureseth, and Green we would have but little trouble, but there are labor leaders who seem to have no interest in either their adopted country or what it stands for. The union leadership with which we are here most concerned is generally believed to be honeycombed with communistic borers-from-within, and this infestation compels the belief that as time goes on this union will have less and less in common with the high ideals of the professional engineer.

[1] A second group of letters commenting on an article "Unionization of Engineers," by James H. Herron, Mechanical Engineering, vol. 61, no. 11, November, 1939, pp. 788–789 and 822.

[2] Little Falls, N. Y. Mem. A.S.M.E.

I am not unmindful of the might-makes-right attitude of both great and little business in days gone by and of strikes in one employer's plant fomented almost entirely by connivance of a rival manufacturer with a labor gang financially supported by him, of blacklists, of professional strikebreaking, and all the other injustices that could only have been cured by unionism and by public opinion as the result of publicity, but it is my belief that the time is ripe for a complete overhauling of the relative rights of labor and capital as against the public weal, and short shrift should be given those who urge higher wages for curtailed and inferior work, the exalting of the less efficient, and the stifling of personal initiative of our manual skilled workers who, no less than the farmer, are the backbone of our nation.

The specific question before us may now be answered, with the foregoing comments in mind, by saying that if the employer can and will settle all employer and employee questions with fairness and the employee has the desire to rise above the herd and is willing to do more than he is paid for to achieve that success, there is little reason for an engineering technician to join any union.

If the employer is unfair, in the true sense of that much unfairly used word, the employees should join a horizontal union showing a disposition to consider the rights of the public as well as those of capital and labor.

To join a vertical union would more quickly bring personal advantage in the way of salary and working hours, but before they aid in the building up of a Frankenstein monster I beg that the boys seriously consider their ability later to destroy that creature when the time comes, and it surely will come, that we must decide between American ideals and the belief that commissars alone have power to work out our individual destinies and decide our every act, in a country where everything that is not required is forbidden.

HENRY H. SNELLING.[3]

TO THE EDITOR:

In James H. Herron's article he mentions the responsibility of the engineering societies relative to the economic status of all professional groups. He also points out the wide difference between the aims of professional groups and the union groups.

There is the possibility that labor unions could be more valuable to a community if young engineers, with the ideals of the professional engineer, were to join the unions and take a leading part in union activities. This course does not seem particularly promising. There is the alternative possibility that the engineering profession could set an example for the unions to see, by broadening the scope of engineering societies to include an interest in the income of members.

It has been suggested before this that the influence of the A.S.M.E. might be used to improve the economic status of its members. Such suggestions have invariably met with the objection that such a course would be contrary to the ethics of a profession. To be sure, engineering is an alleged profession but the societies have done little to bring about a professional standing for engineers. It seems to me that someone is being kidded. The vast majority of engineers are no more professional men than plant superintendents and managers or foremen. If we essay a comparison between engineering and the professions of medicine, law, or dentistry we find a lot yet to be done before engineering will have the prestige or the organizational mechanics of professions. The true professions have always had registration laws which have limited the field and made it possible for the doctor or lawyer to set his own price—usually *after* rendition of his services.

Engineers, with the exception of consultants, do not work the same way at all. The only way for an approach to the problem of an improved economic status is the very direct approach employing some of the principles of the labor unions. One member said to me, "And lose our professional standing?" That is a double-edged joke.

Here is a pertinent fact: There are many engineers who are at present unemployed or poorly employed. You can rest assured someone will pick up the gauntlet on their behalf and that they will be grateful—to the extent of paying dues. Will the engineering societies enter the list on behalf of their members or will the unions execute a coup d'état.

Here is another pertinent fact: The very nature of the A.S.M.E. is such that it is managed by men who have very closely attained a professional status and are many years removed from the problems of earning a small living. All of that is a different story but, until the individual members through local sections and professional divisions have a direct voice in the management, this statement is a challenge to Council to give this whole question more thought than ever before.

The question is, can the A.S.M.E. afford to stand on its dignity and high ideals of professional conduct, or must it become a "limited pressure" group exerting pressure on its members to increase their value to the employer and exerting pressure on employers to increase the pay of engineers?

If pressure, what form can it take and what will be the result so far as accepted ideals and ethics of the A.S.M.E. are concerned?

There have been studies of salary brackets in proportion to the degree of responsibility. San Francisco Engineering Council made such a study, report of which is in A.S.M.E. files. Additional copies are available. At this stage of the proceedings it would not be possible to demand those salaries for A.S.M.E. members but it would be possible to make the employer conscious of such salary brackets. Obviously, the correct solution is registration of engineers, but uniform registration laws will be slow in coming until engineering societies take a positive stand. At the present time, the labor unions are opposing registration because they know it spells the finish of their efforts to unionize engineers.

Pressure on members is already applied in the form of requirements for membership and for advancement to higher grades of membership. There is no prohibition against having other grades of membership if further grading is necessary.

If pressure, what of the A.S.M.E.? First, the Society will become more attractive to younger members and prospective members and will soon be a stronger and more potent force. Many of our engineering problems are inseparable from social problems and we need a large membership if we are to do any more than *talk* about social responsibilities. More members seems like an asset.

Secondly, registration of engineers is essential to our professional aspirations. By increasing our numbers we can seek desirable legislation. That seems like an asset.

Thirdly, by pursuing an intelligent "pressure" course we should be able to accomplish some of the good and avoid the evils of unionism. Such a procedure should stand out as a valuable object lesson to the present pressure groups and a service would be rendered to society. That seems like an asset.

In conclusion I wish to acknowledge all of the objections to any suggestions that the A.S.M.E. become a "pressure group." All such ideas are contrary to the ideals of the Society and these ideals have withstood the test of time. Any such course would seriously affect the professional standing of the fine engineers who are leaders in the Society. But I am not so sure that the effect would be adverse. Furthermore, I would emphasize

[3] Washington, D. C. Vice-President A.S.M.E.

the fact that few of the members of the A.S.M.E. are professionals in fact. The great majority of members would like to have a professional status. They have the ideals of the professional man. So I believe it is conceivable that a new interpretation be placed on the ideals and ethics of the Society in so far as our relations with society are concerned. It is a very fine thing to be unselfish, but it is my observation that the professions of law and medicine have very definitely put on the pressure many times and in many ways.

The ideals of the engineer must give primary consideration to service to society and must reflect an unselfish attitude. In a world full of pressure groups, the engineering societies must inspire engineers to high ideals—but the societies must also look to the welfare of the members.

S. R. Dows.[4]

TO THE EDITOR:

It was with much interest that I read the paper on "Unionization of Engineers," and I welcome the opportunity of commenting on this subject so vital to the engineering profession.

I believe that the alleged causes and inequities promoting a movement in that direction can best be determined by an open and thorough airing in the publications of the major engineering societies, as well as by frequent discussions at section meetings, regional conferences, and other gatherings of engineers. In any case, it is a problem that should be attacked by the engineering societies as a body, and not by individual engineers whose efforts may, at the best, result in a newspaper account covering two inches, or less, of space.

The unfavorable balance in supply and demand has placed many engineers in positions where they cannot profitably engage in their chosen profession, but have had to resort to manual labor, not requiring technical skill or education, but which has offered a better means of subsistence and security. The plight of the young engineer with little experience, and the engineering graduate, just coming out of college, in particular, has been taken advantage of by many manufacturers. And, their victimizing by labor organizations, as well as their low resistance to union propaganda, can well be understood in the light of such treatment. It will be a sad day, indeed, when the professional engineer will be required to take dictates from the "professional" labor-union organizer and will be required to display his union card with photograph and seal before being allowed to enter his own office. Although that time may be a bit remote, indications are that it is on its way, and only determined and immediate action on the part of the employer and the responsible engineer can prevent and cure this "disease" while it is yet in its incipient stage.

GOSTA R. TRUEDSSON.[5]

TO THE EDITOR:

I have received a letter from the Committee on the Economic Status of the Engineer, which poses the following question: "Are the aims and procedures of labor unions compatible with the ethics of the engineering profession?"

I have read with intense interest Mr. Herron's paper in the November issue of MECHANICAL ENGINEERING, entitled "Unionization of Engineers." My impression of Mr. Herron's paper was that he makes very sound and convincing arguments against the unionization of engineers, and I heartily agree with him in these particulars. He indicates that the subject may be open for discussion and that there may be some arguments for the unionization of engineers in the lower brackets or those engaged in subprofessional work.

It is my own firm conviction that such a step would be unwise and eventually destructive to the engineering profession, this for the reason that thinking and brains cannot be unionized. Unlike labor, the services of an engineer cannot be measured in units of time and work. His duties are to advise, counsel, and plan, and are essentially mental in their nature. The engineer offers a professional service, and his contribution to his clients and society differs from labor in that he conceives and plans the things on which labor and artisans perform their work. It is only through his own professional groups or societies that his economic status can be advanced. His affiliation with labor unions, in any form, would certainly lower his status in the opinion of the public, and would very likely lessen or destroy his own self-respect and esteem.

Those engaged in the subprofessional branches of engineering would certainly close the door against their future advance and progress, as I have seen from actual experience many men of this type advance to the top of their profession, or be called to positions of great responsibility in industry.

It is not my desire to criticize the legitimate aims of labor nor to argue against its unionization or organization in any form that will improve working conditions or economic status; I do, however, contend that those engaged in engineering work, in any of its branches, are not properly objects for unionization. The public would not be benefited or better served by such a step. Controversy, ill-will, and discord would certainly result from such a step, and only a few subprofessional men and the least ambitious would gain thereby. Unionization o engineers would greatly aid the professional labor leader whose record today is too well known for comment.

I am very glad that Mr. Herron's article is being given the consideration it deserves and believe that it is timely to get the engineering profession's opinion crystallized on this important matter.

JNO. A. MCPHERSON.[6]

TO THE EDITOR:

It is easy to agree with the assertion that engineers and labor unions have naturally little in common and with the implication that the subprofessional technical groups tend toward the unnatural. The medicos have the subprofessional problem and have established a line of demarcation so clear as to constitute a caste division. With us, the line has been, may be, and will be crossed in exceptional cases, as it is (although much less frequently) in the military services.

"Service first, then salary" is an eternally valid principle, but may not satisfy those who are already flirting with the union idea, perhaps stimulated to do so by many situations where the y of salary is imperfectly responsive to variations in the x of service. Other principles might be suggested, such as:

(1) Labor and the engineer are often in apparent conflict. Engineering development may cause temporary unemployment, for example.

(2) Unionization is distinctly a class movement. Engineers are outstanding in their lack of class consciousness.

(3) All engineers may aspire to, and many achieve, positions of administrative leadership. Unions cannot help and may hinder.

Today, professions tend toward unionistic practices. County medical societies demand affiliation under penalty of economic ostracism. Bar groups recommend standard fees, e.g., $200 to defend against a charge of drunken driving. Teachers in the public schools and college professors have their union setups. Engineering societies are preoccupied with statistics of earnings and with standardization of engineering salaries in government service. One founder society

[4] Albany, Calif. Mem. A.S.M.E.

[5] Hartford, Conn. Mem. A.S.M.E.

[6] Greenville, S. C. Mem. A.S.M.E.

committee and at least one state society of professional engineers have recently tabulated recommended standard minimum fees and salaries for various classes of work or grades of position.

All of this perhaps naturally leads toward Past-President Herron's suggestion that the engineering societies become sublimated representatives for collective bargaining (if that is a fair description). Unlike the unions, they are, or can be, in a position to certify as to competence. But—also unlike them—they have the problem of *grades* of competence. Thus there would need to be a *series* of minimum rates of pay. Previous experience in the engineering field and elsewhere indicates that these rates would be below any which would concern the better men in the respective grades; and that minima would be raised at the expense of other rates, thus decreasing the present emphasis on effectiveness. In the A.S.M.E., only a small fraction of the membership would ever be affected by any absolute minimum. Within this fraction—as in unionized trades generally—the minimum or *a* minimum would tend to become the actual rate.

But the important thing about Mr. Herron's suggestion is the new departure it would constitute in the Society's objectives. There have been many departures during the last forty years, perhaps not all for the better. Possibly we need to glance back briefly to a time when the Society conferred, in membership, just two things: prestige, and the opportunity to excel in an environment of excellence.

WILLIAM D. ENNIS.[7]

TO THE EDITOR:

To an old-timer the suggestion of an alliance of engineers with a typical labor union, with a typical business agent for a boss, smacks of miscegenation.

There is no argument that such an alliance will promote the members' professional prospects; indeed the tendency would be the other way, but as it may and sometimes does increase the size of his salary check; membership in a union is a lure that is attracting the attention of many young engineers.

The business of organizing and managing new unions is so profitable that prospectors are continually on the lookout for unorganized groups that, at first by cajolery and later by duress, may be brought under the wing of some powerful national union, where the members, to retain their rights to work, submit to taxation in the form of initiation fees and monthly dues. A union of sufficient strength can and does get for its members increased pay and/or decreased hours of work. Such benefits, however, are not that much newly created wealth for the world, and they would not accrue to the union members if the conditions of their employment were governed by the rule of supply and demand; they are a tax on society in the interest of a preferred group and that tax, society must pay. The employer does not stand the increased cost. He passes it on to the dear public that does not recognize its source.

The effect of thus arbitrarily raising the wage rate above what is paid in comparable lines of employment, is a tendency to attract an increased amount of help to those positions whose rates of pay have been thus inflated, thereby bringing in more help than the business requires, resulting in part-time work and a decrease in the monthly wage.

In agriculture the overabundance of food, resulting in part from governmental efforts to increase food production, was corrected by plowing under growing crops and little pigs, but, as that humane method of disposing of a troublesome surplus of food cannot be applied to an engineer surplus, it is overcome by slowing up the workers, or by merely reducing their hours of work while leaving the monthly pay the same, thus again attracting more young men to the profession, and requiring further correction of the same kind.

But this method of controlling progress up the circular ascending stairs is crude and difficult to apply. Really, the unions should control the trouble at its source, by restricting the output of engineers from the technical schools by organizing the professors in the usual way, and have them limit the number of students they will admit to engineering courses, or would it be simpler to have them flunk out half of each class?

The practice of limiting the number of workers in a given trade by limiting the number who may enter it has worked well in practice.

In fact, among tool and die makers the restriction has been so effective that the Army Ordnance Department is at a loss to know where a sufficient number of this class can be found to tool up machine shops for a wholesale production of munitions in case of war.

But why all this fuss about a condition that has long been with us and which is recently reaching into the engineering profession? Here is a recent example: In the engineering department of a certain municipality, a group of employees were persuaded that they were underpaid because they were receiving less than was paid to a group of organized mechanics who worked under the supervision of the engineers. Appeals to the authorities for consideration were met by a stern, "No! We are here to conserve the taxpayers' money." Finally, the petitioners were given a quiet tip that they, the officials, would listen to the appeal if it were presented by a union business agent.

Enough said! The union was organized and the members paid their initiation fees and dues. On advice, a certain person was elected business agent, whereupon the long-prayed-for increase was granted. There was, however, a small fly in the ointment. The business agent selected for them was a "rough fellow," not a fellow employee and not an engineer, but he knew his way around with other business agents. Not long after he had been in office, he put through a rule increasing the dues "to cover organizing expenses and other matters." Some of the Knights of the Slide Rule, who could not figure out the need for all of the new money and detecting a bad odor, dropped their membership in the union, being protected in their jobs by civil-service appointment. As, according to the code, a good union engineer would be defiled by working on a drawing board next to a "scab," a strike was called and, at this writing, is still on. Meantime, the erring brothers are being worked on to bring them into the fold.

It is hoped that the christianization of the nonconformists will not require the use of third-degree union methods.

The conservatism of the engineer, his high standard of ethics and his loyalty to his employer, have contributed materially to the high standing of the profession, from whose ranks have risen captains of industry whose organizations have created employment for millions. Should this condition give way to one in which the members of the profession would allow themselves to be organized, held in strict discipline by a business agent, and arrayed in armed neutrality facing the employer ready to take every advantage of the employer's necessities, the old relation would no longer exist and the engineering profession would sink to the level of a labor union with its concomitants of graft, strife, and lawlessness, and disregard for public interests.

Happily, such a condition cannot be conceived, and although servile public officials may come under the dominance of union leaders, leaders of industry are still maintaining their independence. They may, under the pressure of national unions, be forced to recognize organizations of draftsmen and of some in higher positions, but those required for

[7] Hoboken, N. J. Fellow A.S.M.E.

positions of trust and of leadership will not be sought in those ranks. It may result in two classes of engineers; one, the union of labor affiliates with its selfish purpose and sordid methods; the other, the professional engineer of the old ideals of ethics, loyalty, and true engineering delight in the advancement of the profession, and in rendering public service.

W. L. ABBOTT.[8]

TO THE EDITOR:

I am very much interested in the subject discussed by James H. Herron in the November issue of MECHANICAL ENGINEERING. As director of the Placement Bureau at Case School of Applied Science, I have had an opportunity to discuss the problem of unionization with our graduates and wish to offer the following case histories as typical of the experience of our men who have been faced with the union problem.

A graduate of the class of 1933 secured a job with one of the railroads as a mechanical apprentice and started on a three-year program of training in the company's shops. He was asked to join the company union and did so but dropped his membership when the union affiliated with the A.F.of L. He complained that the new leaders acted like little children and ran to the superintendent with every petty grievance. During the next year the company laid off a number of men including the Case graduate. When these men were later recalled, the union insisted that the company refuse the young man's request for a short extension of time which he needed to finish a temporary job he had undertaken. As a result he lost his job with the railroad and blames it entirely on the union leaders.

Another of our men took a position with one of the large Akron rubber companies and after spending six months in the drafting room asked to be transferred to the shop. The company was glad to grant his request and placed him on special electrical control work in the plant. He worked only two days, however, before the union entered a formal complaint and forced the company to remove the young man from work which he wanted to do and which the company was interested in having him do.

A third case which has come to my attention concerns a young mechanical engineer who secured a position with a large machine-tool manufacturer. The union in this plant was successful in organizing all of the sixty men in the drafting room with the exception of the young graduate. He refused to join and was immediately ostracized by his fellow workmen who refused to speak to him even on business matters. He withstood this treatment for two weeks and then quit his job.

I shall follow the discussion of the unionization of engineers with interest, and hope that some principles can be evolved which will be of help to young engineers who are faced with this problem.

J. J. MOORE.[9]

TO THE EDITOR:

I have read Mr. Herron's article on Unionization of Engineers, in the November issue, with great interest. Mr. Herron outlines very well the conservative and traditional viewpoint of the relation between unions and engineers and it is with a great deal of hesitation that I presume to point out what appears to me to be defects in an outline prepared by a man of Mr. Herron's experience and wisdom. However, I will justify my discussion by his kind invitation to discuss the matter.

It seems to me that, in writing of unions, Mr. Herron is guilty of the same mistake that he complains has been made in writing of corporations. He complains that all corporations were charged with the abuses of a few, he then, inferentially at least, charges all unions with the abuses of a few. There are many unions and union officials who haven't any more use for the C.I.O. than has Mr. Herron. I know of one union in San Francisco that has over $100,000 cash (this seems like plentiful resources for a small union) whose officers boast that they have not had a strike in over thirty years. Surely Mr. Herron knows that unions have cooperated with management to increase production. (This is not typical but it does indicate a possibility and, I hope, a trend.)

It may have been correct at one time to group capital and management together but I believe that most economists agree that, in general, managers no longer own the properties thay manage. Instead, management has become a hired function and the manager an employee.

It seems to me that Mr. Herron contradicts himself when he says, "The engineer should think of service as his principal concern," and then in a later paragraph, "The employed engineer desires, above all else, a fair compensation and steady employment." (The unemployed engineer desires the same thing.) Again there seems to be a contradiction in the ideas that "labor-union ideals and professional ideals cannot be made to harmonize," and the later statement that "the engineering societies should charge themselves with responsibility relative to the economic status of all professional groups." If they assume responsibility relative to the economic status of their members will they not, as far as that function is concerned, be unions?

He says that "it is hoped that collective bargaining need not be resorted to." What is the practical difference between collective bargaining as practiced by the conservative unions and a salary schedule set up by a society fixing the compensation to be paid to its members? This seems to be what Mr. Herron suggests that the societies should do.

This problem might be attacked as follows: Grant that collective bargaining is a necessary and accepted procedure in modern industry. (Mr. Herron seems to assume this when he suggests that the societies assume responsibility for the economic status of its members.) Either encourage young engineers to join a union, become active in it, and furnish high-class leadership, the inferior quality of which Mr. Herron states, or induce the engineering societies to perform the functions which the unions perform.

Some of the societies are now doing something. The American Society of Civil Engineers has done a good deal of work in working up a code of standard compensation for engineers and the San Francisco Engineering Council worked up a list of recommended salaries for engineers and submitted it to the Civil Service Commission of San Francisco and to some private employers.

Our young engineers are inclined to be conservative and I think that if encouraged they would have a very leavening effect on the unions with the result that the policy of labor would more generally be what it should be rather than that of the C.I.O. It is quite possible that these engineers would leave the union when they worked up to a position where they could properly call themselves professional engineers.

The engineering societies should determine whether they will do the work of the unions, as Mr. Herron suggests, or they should frankly say that such work is a function of some other agency.

GEORGE L. SULLIVAN.[10]

TO THE EDITOR:

I'm not sure whether or not engineers should join unions. I do think that the fact that the problem has become important shows a need. And when there is a need, there is also an opportunity.

[8] Chicago, Ill. Past-President A.S.M.E.

[9] Cleveland, Ohio. Nonmember.

[10] Santa Clara, Calif. Mem. A.S.M.E.

In this case, I think it is an opportunity for our Society.

What can the Society do? I think the most important and useful thing is the collection, interpretation, and dissemination of data. Salaries, working conditions, hours, hazards, types of work, promotional possibilities, size of organization—all of these things are matters of vital concern to engineers in their own organization—yet how many know about these things outside their organization? And how many know salaries in their own organization? Our economy is based on the principle of well-informed buyer and seller, and here is a chance to inform both. You say a practical program is difficult to work out. Granted. But here are suggestions:

The first step is to find out what engineers do, so as to have some definitions to work from. A committee of engineer-supervisors might set up some tentative statements of duties and responsibilities for several different classes of engineering work. These classes ought to correspond roughly with the committee's idea of salary groups.

With these duties statements as a basis, members and employers of engineers could be asked to state what salaries are paid for each class in their individual cases. Getting this information from two sources would provide a check on accuracy. Interpretation of data to put it into usable form would involve constant critical appraisal of results and methods, and would show the need for changes and additional information.

Presenting the results would probably first be done to local members in a given area. In time a national "Standards of Compensation for Engineers" to protect both employer and engineer from exploitation and to serve as a guide for public and private officials in setting up wage scales, might be evolved. Frequent revision to meet changing conditions would suggest some such physical form as a loose-leaf book.

"Too much work!" No. This type of thing has already been done by the American Library Association and most public personnel agencies that have a salary standardization plan have gone into the problems. It is up to us, as members of the A.S.M.E., to work out a fair and equitable method of furnishing ourselves and others with this information.

If we do this, it seems to me that we will go a long way toward removing one handicap which has caused the engineer to consider unionization.

BAXTER H. WEBB.[11]

Modern Timber Construction

TO THE EDITOR:

The author of this paper[12] has given an excellent survey of the present status of timber as a material of engineering construction. Unquestionably, timber now has a place in the economics of structures which it has not enjoyed during the last four decades. That this situation is changing is evidenced by such papers as the one under discussion.

The writer would like to add a few words to Mr. Pantke's statements regarding glued laminated construction. It has been reported elsewhere that this method was introduced as early as 1907 in Germany and Switzerland, where it has been used for bridges, as well as for buildings. Many of these structures have been in use over a period of years, long enough to establish the serviceability of the method. Recent tests of glued laminated arches and rigid frames, made at the University of Illinois Engineering Experiment Station, have shown that units made up of thin boards, glued together and bent to conform to the shape of the arch axis, behave in a manner which, for all practical purposes, is the same as though the unit had been made of a solid piece of timber.

The specimens which had a span of 17 ft 6 in. were tested in a 300,000-lb Riehle testing machine. By means of a system of levers supported upon knife-edges, they were loaded at 6 equally spaced points along the unit, Fig. 1. They were tested as two-hinged arches, there being no restraint against rotation except frictional at either springing line. The vertical reactions were measured on the weighing bed of the testing machine, and the horizontal thrusts were determined from the compression of calibrated springs through which passed horizontal steel tie rods, Fig. 1.

A graph showing a comparison of meas-

[11] Detroit, Mich. Jun. A.S.M.E.

[12] "Modern Timber Construction," by C. Pantke, MECHANICAL ENGINEERING, November, 1939, pp. 791–798.

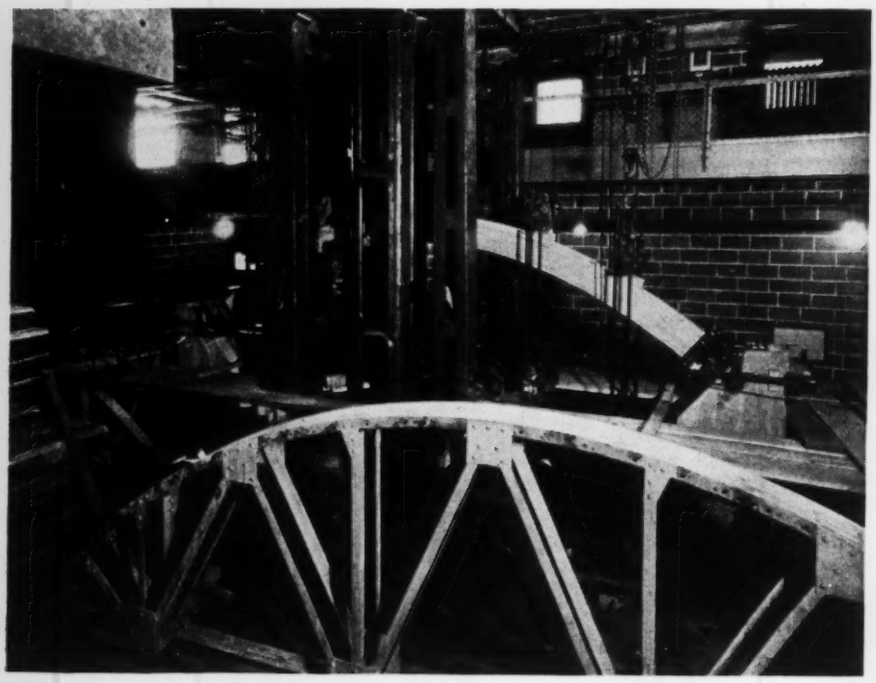


FIG. 1 TESTING GLUED LAMINATED-TIMBER ARCH

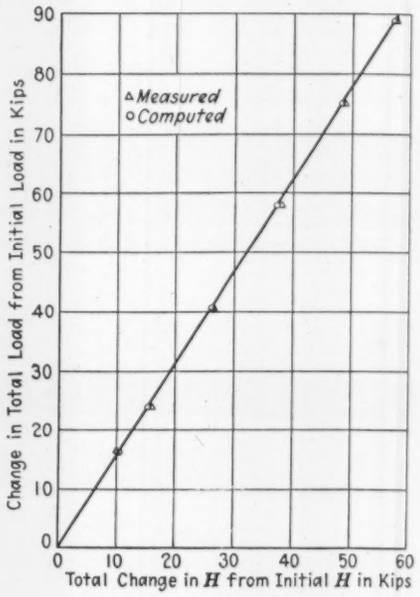


FIG. 2 COMPARISON OF MEASURED AND COMPUTED VALUES OF HORIZONTAL THRUST

ured and computed horizontal thrusts which is typical of the results obtained is shown in Fig. 2. The measured thrusts were determined from the conventional theory of elasticity as applied to two-hinged arches, assuming a specimen of homogeneous material with elastic properties equal to the average of the wood from which the specimen was made. Stresses, obtained from strains measured at various points along the arch, also compared well with computed stresses. Furthermore, the measured ultimate strength of the specimen compared well with the expected strength.

While the foregoing description of the tests is of necessity sketchy and incomplete, the writer believes that there is sufficient information included to indicate the reliability and usefulness of the method where properly used. He might add that already there has been built in the United States a comparatively large number of glued laminated-timber structures.

WM. A. OLIVER.[13]

TO THE EDITOR:

Some experiments recently carried out at the Massachusetts Institute of Technology may be of interest. The stress-strain diagram for solid wooden beams or for laminated beams, composed of laminations all of the same species, shows the familiar triangular distribution, with maximum compression at the top, maximum tension at the bottom, and straight-line variation in between. (This is approximately true.) If, however, top and bottom laminations are composed of denser species, possessing a higher modulus of elasticity than the core, the stresses in these laminations (if straight-line strain distribution from top to bottom is assumed) should be greater than in the same laminations of the one-species beam by the ratio of the moduli of elasticity of the two species. This should provide a resisting moment analogous to that of an I-beam, resulting in what might be called a rectangular I-beam.

To test this theory, three sets of small beams were made up, all using common eastern spruce bill stuff for cores but with glued outside laminations of highest-grade Douglas fir, long-leaf yellow pine, and South American greenheart. All were tested under center-point loading with the load applied at approximately 0.1 in. per min.

The beams, using Douglas fir and long-leaf yellow pine, had practically the same strength characteristics as solid beams of the same high-grade material would have, with the exception of modulus of elasticity which was somewhat lower. Beams using greenheart, while less strong than solid greenheart, were materially stronger, however, than beams of the strongest and best-grade native species.

Several interesting possibilities develop as a result. Lumbermen find difficulty in disposing of low-grade lumber. Laminated beams, using both low- and high-grade lumber, judiciously combined, might help to solve their problem. Species hitherto too expensive to use for structural purposes might be made available. Finally, it is possible that the effect of defects in lumber, which ordinarily cause serious weakening, can be partially overcome in cores by the laminations of high-grade material surrounding them, much as the concrete in concrete-filled steel pipe columns seems to be strengthened by the restraining influence of the surrounding steel.

ALBERT DIETZ.[14]

Design and Operation of De Florez Furnaces

TO THE EDITOR:

Probably there are many who will agree that De Florez furnaces[15] are very good furnaces for some purposes and yet may be unwilling to concede that this design is the ideal beyond which no future progress may be expected. The good features of this furnace include a fairly simple structure and moderately uniform heat distribution over the radiant absorption section. Against this however, is the fact that they are apparently rather expensive to build, do not lend themselves so readily to the addition of a convection section as do other types, and are not so readily adaptable to change the flow into increasing numbers of tubes as expansion takes place in a fluid that is being evaporated as it is heated.

The cost of the furnace is not given, but a rough estimate, based on the data supplied in the paper, indicates that this type of furnace might cost 30 to 50 per cent more than other types having similar total heat absorption.

The use of a circular cross section is a step readily perceived as soon as one starts to think about securing uniform exposure of the tubes to a source of radiant energy. Independently of Mr. De Florez, the writer made designs of furnaces of circular cross section, both with the tubes arranged cylindrically and conically (the latter with the idea of improving the exposure of the tubes farthest from the burner), and with burners either in the top or bottom. The greater expense of securing a circular cross section for a thermosiphon heater and, particularly, the great difficulty of securing uniform distribution of liquid in a design in which all tubes were in parallel, led to the construction of a number of furnaces with vertical tubes having a square rather than a circular section.

There are numerous features involved in the design of oil heaters which are capable of economic analysis. The writer is now preparing a paper on this subject, and the present discussion will be concerned largely with questions of economics of design.

TWO ROWS OF TUBES INSTEAD OF ONE

The first point to be noted is that the furnace is provided with two rows of tubes instead of a single row. There are many cases where the process requirement is such that it is desired to heat the fluid quickly and then maintain this temperature or increase it but slightly for a period of time. This is particularly true in certain cracking processes where a "soaking" period is desired, after the oil has once been raised as rapidly as possible to the required temperature, to provide time for the reaction. In such cases, the use of multiple rows of tubes exposed to radiation may be desirable. However, where such considerations do not govern and the question is merely one of heating the fluid at a minimum investment, a single row of tubes is all that can be justified in a radiant section.

It can be demonstrated that two rows of tubes, spaced as in this De Florez design (approximately $2^1/_2$ diam apart), should absorb approximately 96 per cent of the incident radiation, including reflection from the back wall, if they have black surfaces for radiant absorption purposes.

A single row of tubes with the same spacing will absorb approximately 80 per cent of the incident radiation. It is assumed that, in both arrangements, the tubes are backed up by a refractory insulating wall through which the heat losses are negligible and which is located far enough behind them to secure over their rear surfaces a fairly uniform distribution of the energy that passes between the tubes and heats up the rear wall.

Consequently, if a single row of tubes were used in place of the double row in the same size of furnace as given in this

[13] Assistant Professor of Civil Engineering, University of Illinois, Urbana, Ill.

[14] Department of Building Construction, Massachusetts Institute of Technology, Cambridge, Mass.

[15] "Design and Operation of De Florez Furnaces," by George D. Leslie, MECHANICAL ENGINEERING, July, 1939, pp. 503–510.

design, the heat absorption would be 80/96, or 83.3 per cent as much as would occur with the present arrangement. This will mean a greater average absorption per square foot of tube, but not a greater maximum rate of heat absorption on the surface nearest the flame, which is most severely exposed. The difference lies in the additional radiation absorbed on the backs of the tubes by reflection from the refractory wall.

To obtain the same total heat absorption, 91 tubes in a single row would be required in place of the 152 used in the double row, which would necessitate increasing the diameter of the structure about 20 per cent, to 30 ft instead of 25 ft. There would be no particular financial advantage in this change. However, a spacing of $2^1/_2$ diam is not necessarily the optimum spacing for a single row.

The best spacing for tubes depends upon the relative cost of the tubes and headers as compared with the cost of the walls and supporting structure. A complete analysis would require checking a number of designs with different spacings. For the purposes of this discussion, however, a comparison is made between a spacing of 2 diam and $2^1/_2$ diam. With tubes spaced 2 diam apart, a single row will absorb 88 per cent of the incident radiation as against 96 per cent for two rows spaced $2^1/_2$ diam. Such an arrangement would therefore require 83 tubes in place of the 152 given in the De Florez design and would require increasing the diameter to about 27 ft 3 in. instead of 25 ft.

COMPARATIVE COSTS

A rough estimate indicates that, if the tubes in a De Florez design are made of 4–6 per cent chromium alloy, the cost of the tubes and headers probably represents slightly more than one half the total cost of the furnace. With these data, we may proceed to develop a comparison between the design as given and an alternative with a single row of tubes. Assuming the present total cost is y, the cost of the tubes alone may be taken as $0.50\,y$, and the cost of the walls and supporting structure as $0.50\,y$. With a single row spaced 2 diam, only 83 tubes would be required instead of 152, so that the cost of the tubes would then become $0.50\,y \times 83/152 = 0.273\,y$. The increased diameter will increase the cost of the walls and supporting structure approximately proportionately to the diameter, making this cost become $0.50\,y \times 83/76 = 0.545\,y$. The total cost in this case would then be $0.818\,y$, making a saving of approximately 18 per cent. The 2-diam spacing chosen is not necessarily the optimum. If the tubes were made of more expensive material, such as 18–8 per cent chrome nickel, a wider spacing might be indicated. Even for the 4–6 per cent chromium-alloy tubes assumed, some other spacing might be more economical.

It is undoubtedly more expensive to make the cross section of the furnace circular than to make it rectangular. This added cost must be justified on the basis of obtaining more uniform exposure to the radiation than can be obtained with the latter design. It is not, however, always essential to have uniform exposure or uniform heat absorption in various tubes in an oil heater. The limitation on rate of heat absorption per square foot of the most exposed surface is usually determined by the tendency of the oil to crack and deposit coke on such surfaces where the metal-wall temperature is highest. In a heater in which the oil enters at a relatively low temperature, compared with its outlet temperature, it is possible to have very much higher rates of heat absorption in the tubes carrying the colder oil. It is readily possible that radiant absorption rates may be satisfactory in parts of the furnace that are two or three times as high as that which can be permitted in parts where the oil is hotter. With this in mind, a furnace having nonuniform heat distribution might be entirely satisfactory, or even more desirable and economical for such service. It should also be noted that, while it should be fairly easy to obtain a uniform distribution of heat circumferentially in a De Florez heater, the distribution longitudinally will not be as uniform. The vertical arrangement of the tubes and their connection in series limits the allowable heat absorption to that which is permissible for the hottest tubes.

USE OF AIR PREHEATER

In the design discussed, economy (and quite good economy) is obtained by the use of an air preheater. With this particular design, this is probably the simplest solution. However, it does not follow that an air preheater is preferable in all cases to a convection bank or vice versa. This will depend upon the inlet temperature of the oil to the heater. If the oil enters relatively cold, it may be more economical to secure the optimum efficiency by means of a convection bank. If the oil enters the furnace very hot, as in cracking furnaces, the optimum amount of convection bank may be very small. However, the writer has found that, even for oil entering a heater as hot as 850 F, it is still economical to put in some convection bank in addition to an air preheater. This is so because, with such high oil inlet temperatures, the flue-gas exit temperature from the furnace becomes so high that ordinary carbon-steel materials are not satisfactory in the air preheater, which may burn out by oxidation. A complete economic design, therefore, involves first determining whether a convection bank or an air preheater will be more economical or whether a combination of the two will give the optimum economy. Optimum economy does not necessarily mean maximum efficiency, because the value which can be placed on the fuel saving will determine how far it is economical to go in saving heat that would otherwise go up the stack. If both an air preheater and a convection bank are used, each will be smaller than would be the case if either were used alone. In making the comparison, it must not be overlooked that there is a jump in cost as soon as an air preheater becomes involved, because of the addition of the blowers.

It is claimed by the author that the De Florez heater has the advantage of high efficiency. This is not peculiar to this design. The writer has designed a cracking furnace of practically identical efficiency which embodies both convection bank and air preheaters in addition to the radiant bank, and which is believed to be less expensive. The De Florez furnace should have no advantage in maintenance cost of brickwork over any other radiant furnace having the walls covered with heat-absorbing tubes. As a matter of fact, in a properly designed oil heater, having a radiant absorbing section, the absorption by radiation reduces the furnace temperatures to such a point that conditions are very mild on the brickwork, and second- or third-grade brick may be safely used.

One further minor point may be noted in connection with the statement that thermocouples extend through the furnace walls to determine "the so-called furnace temperatures;" this is to the effect that "in reality the couples measure the temperature of the furnace gases coming in contact with the tubes." This statement is only approximate. Actually the pyrometer measures the temperature of the thermocouple point and this and its surrounding well will always be at a lower temperature than the hot gases, where the thermocouple well is so located that it can "see" some colder absorbing surface. The error depends upon the diameter of the thermocouple tube, its relative exposure to the colder absorbing surfaces, as well as the temperature of the latter, and the temperature of the gases. It may amount to several hundred degrees. In this particular situation, the actual flue-gas temperature, measured by

such a thermocouple, may be perhaps 150 deg low. More elaborate precautions must be taken, however, to obtain actual gas temperatures, such as taking the gases out at high velocity through an insulating tube surrounding the thermocouple point (the so-called "durchfluss" pyrometer).

F. L. MAKER.[16]

Requisites for Engineering Leadership

TO THE EDITOR:

A. R. Stevenson, Jr.'s quotation[17] from Kipling:

"They copied all they could copy
But they could not copy my mind
And I left them sweating and stealing
A year and a half behind."

reminds me of the favorite saying—"Damn the man who steals my plans, and damn the man who does not know enough to"— of a brilliant mechanical engineer, who passed on many years ago, John W. Meserve.

Forty-seven years ago Mr. Meserve, then in charge of the crane department of Yale & Towne at Stamford, Conn., retained me to design a series of standard electric traveling cranes.

In those days there were less than a half dozen firms making such cranes, and a mere glance at a crane was enough to show which firm made it.

At that time I thought that Mr. Meserve was referring to the man who did not appropriate his plans, but in recent years I have thought that he meant—those who did not know enough to steal them correctly.

It is aggravating to have one's plans stolen, but more so to have them stolen and botched.

T. KENNARD THOMSON.[18]

Change in Elevator Safety Code Loading Curve

THE Sectional Committee for the American Standard Safety Code for Elevators, Dumbwaiters, and Escalators, upon the unanimous recommendation of its Subcommittee on Research, Recommendations, and Interpretations, has voted to increase the platform-loading values for passenger elevators and authorizes the substitution of the two curves reproduced herewith for those given as Fig. 4 and Fig. 4A under rule 217a in the 1937 edition of this Code, effective immediately. This change is not retroactive and the posted capacity of existing elevators should not be changed to comply with this loading.

Discussion. It has been known for some time that the allowable loadings per square foot given in the Code frequently are exceeded and recent studies started because of a series of mishaps due to overloading have shown that total platform loads as high as 140 per cent of Code loadings could be obtained on comparatively small (2500-lb capacity) elevators. Whereas 100 lb per sq ft is the maximum given in the loading curve (Fig. 4), it was possible on large platforms to actually obtain loading densities of 141 lb per sq ft by a careful choice of passengers.

The comment on our code received from the London, England, elevator-code committee was to the effect that while the code was very carefully prepared, the loading curves were "quite inadequate."

At least two government departments, both large purchasers of elevator equipment, have voluntarily adopted this new loading curve prior to any official action on the part of this committee.

This statement is intended as an advance notice of this change. A complete discussion of the reasons for it and the method of applying the data given by the new curves will be published later.

[16] Designing Engineer, Engineering Department, Standard Oil Co. of Calif., San Francisco, Calif. Mem. A.S.M.E.

[17] "Requisites for Engineering Leadership," by A. R. Stevenson, Jr., MECHANICAL ENGINEERING, December, 1939, pp. 903–906. (See quotation on page 905.)

[18] Consulting Engineer, New York, N. Y. Life Mem. A.S.M.E.

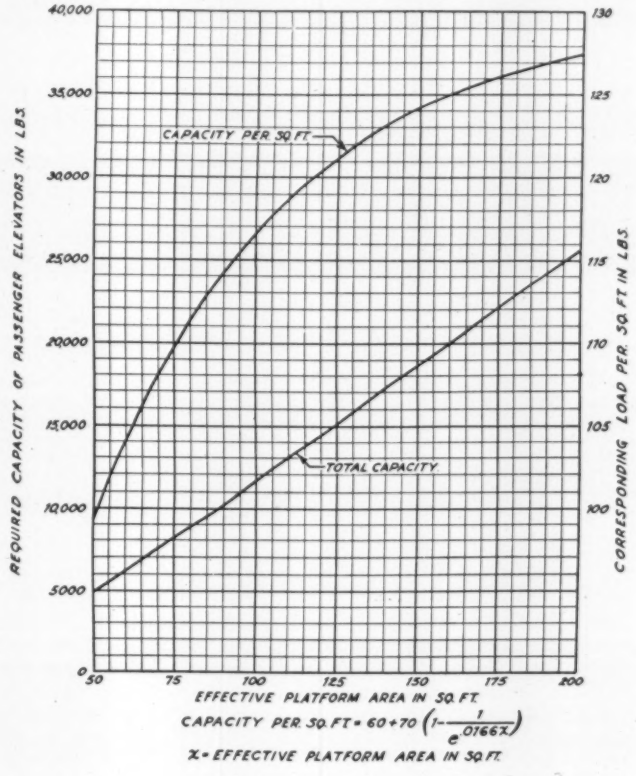

REQUIRED CAPACITY OF PASSENGER ELEVATORS IN LBS.
CORRESPONDING LOAD PER SQ. FT. IN LBS.
CAPACITY PER SQ. FT.
TOTAL CAPACITY
EFFECTIVE PLATFORM AREA IN SQ. FT.
CAPACITY PER SQ. FT. = 60+70 (1−1/e^.0166X)
X = EFFECTIVE PLATFORM AREA IN SQ. FT.

FIG. 4 LEFT

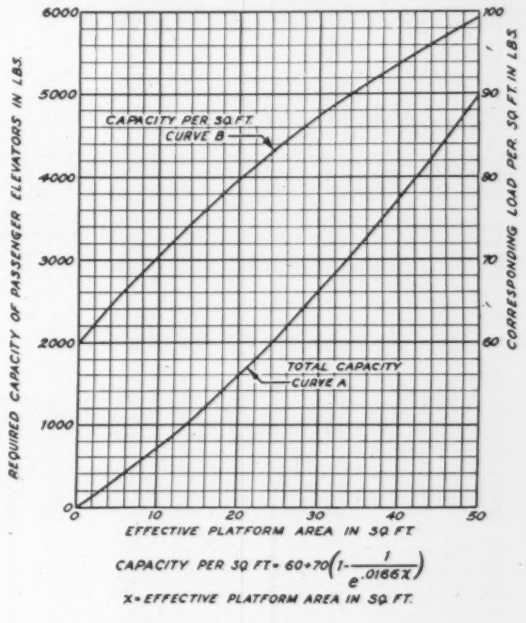

REQUIRED CAPACITY OF PASSENGER ELEVATORS IN LBS.
CORRESPONDING LOAD PER SQ. FT. IN LBS.
CAPACITY PER SQ. FT. CURVE B
TOTAL CAPACITY CURVE A
EFFECTIVE PLATFORM AREA IN SQ. FT.
CAPACITY PER SQ. FT. = 60+70(1−1/e^.0166X)
X = EFFECTIVE PLATFORM AREA IN SQ. FT.

FIG. 4A ABOVE

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The History of Photography

THE HISTORY OF PHOTOGRAPHY, ITS RELATION TO CIVILIZATION AND PRACTICE. By Erich Stenger. Translated by Edward Epstean. Mack Printing Company, Easton, Pa., 1939. Cloth, 6 × 9 in., 204 pp., illus., $5.

REVIEWED BY CYRIL G. R. HUMPHREYS[1]

IT IS difficult to review adequately the contents of this concise volume, for, in a matter of two hundred pages is listed and briefly described, every photographic process and gadget evolved during the last one hundred years. The translator suggests that Dr. Stenger's book is a "true picture of the present German viewpoint of the subject," and we find that their viewpoint is very similar to ours and all the familiar and unfamiliar French, British, and American scientists and experimenters are included, as well as a goodly company of Germans.

The book is in fine literary style, but all too brief, and we would have preferred a more extensive description of each item of major importance, even at the expense of some anecdotes of lesser importance. Everything is described from Schulze's production of an image by the aid of light in 1727 to spirit photography; the latter, by the way, was once described by the Germans as follows: "Ghost photography is a profitable American humbug." If you feel that Schulze is too remote, and if ghosts are outside your class, then inquire within at the intervening 135 pages and find there revealed an assortment of scientific events and ideas that will bring pride in his art to even the humblest box-camera enthusiast. Each of the 165 short subjects is neatly subtitled and separated; there is a good index; and there are many excellent illustrations of history makers and recorders in the field. History lovers will find the book all too brief, but an excellent reference work. The photography enthusiast, active or armchair, who seeks romance in his work will here find most delightful reading—a perfect bedside book. In closing, we quote the opinion of a disgruntled photographer in 1886: "The amateur photographer is a dilettante who owns a more or less complete photographic equipment, which he understands more or less clearly, who pesters his relatives and dependents on whom he bestows the unwelcome gift of his certainly questionable photographs; who, by chance and good fortune produces a tolerable landscape or other scene, using these at every opportunity to advertise his skill and so interfering with the legitimate business of the professional."

Does this fit your case?

[1] Consolidated Edison Company of New York, Inc. Mem. A.S.M.E.

Thurston on the Steam Engine

A HISTORY OF THE GROWTH OF THE STEAM ENGINE. By Robert H. Thurston. Cornell University Press, Ithaca, N. Y. Centennial edition with supplementary chapter by William N. Barnard. Cloth, 5¼ × 7¾ in., 555 pages, indexed, $3.

REVIEWED BY A. G. CHRISTIE[2]

CORNELL University celebrated in October, 1939, the one hundredth anniversary of the birth of Dr. Robert H. Thurston (1839–1903), for many years the director of Sibley College and one of the outstanding engineers of his day. He was instrumental in organizing The American Society of Mechanical Engineers and served as its first president.

Dr. Thurston contributed many learned papers on technical subjects to the various societies and wrote an astounding number of books on engineering. A survey of the titles of these books leaves one impressed at the breadth of knowledge of this author and at his versatility. No more fitting memorial to this great engineer and educator at this centennial could have been chosen by the Cornell executives than the republication of one of these works.

Their choice of "A History of the Growth of the Steam Engine" was a doubly fortunate one. In the first place, it has been regarded by many as Dr. Thurston's best work but one which unfortunately is now seldom available in book stores. A more important consideration is its lasting educational value. The crowded curricula of our colleges leave practically no time for the study of the development of steam machinery nor is this subject discussed in many of the modern texts devoted to steam machinery. One who reads Dr. Thurston's book learns of the slow development of the steam engine based upon the meager scientific knowledge then available and gains an increasing admiration for those pioneers in development who persisted in their work in the face of tremendous difficulties. This broadening of our knowledge of the historical development of the art has a real cultural value.

A perusal of the book makes one marvel at the patience, persistence, and research of the author to secure the facts and data upon early inventions and inventors. Dr. Thurston points out in the opening pages that "great inventions are never, and great discoveries are seldom, the work of any one mind." Hence the steam engine and boiler resulted from the successive contributions of many inventors. Even James Watt, probably the greatest of the inventors of the steam engine, was but one of the many men who aided in its perfection.

The opening chapters trace the early forms of devices employing steam as a form of energy with contributions by Hero, Ctesibius, Branca, Worcester, and Savery. Following these, Papin was the first to develop a steam engine with a piston. It remained for Newcomen to combine the various elements discovered by others into a practical workable steam engine and to apply this engine to industry. This great achievement of Newcomen and his associates is commemorated in Great Britain and America by the foundation of the Newcomen Society for the development and preservation of the early history of engineering developments.

Then came James Watt, who conceived the idea that the inefficiency of Newcomen's engine resulted from the condensation of the steam in the cylinder itself and who then developed the sepa-

[2] Professor of Mechanical Engineering, The Johns Hopkins University, Baltimore, Md. Fellow and Past-President of The American Society of Mechanical Engineers.

rate condenser. Watt and his able partner, Boulton, established the steam engine as the principal source of mechanical power and thereby laid the foundations of future developments in industry. Watt and his successors invented many improvements of the engine and boiler. Dr. Thurston, however, lays little stress on the part played by machine-tool development in the perfection of the steam engine.

Space permits only a brief reference to the chapter on the development of steam locomotives from Cugnot's steam carriage, Oliver Evans' boiler and engine inventions, Trevithick's locomotive, and finally to the works of those great engineers, George and Robert Stephenson.

The chapter on marine-engine development will be of particular interest to Americans. While some of the earliest attempts to apply steam to boats were made in Europe, the principal developments were made in America by John Fitch, Symmington, Morey, and Bell. Finally, Robert Fulton combined the developments of others in successful commercial ships. His work, that of the Stevens, and later of Ericsson with the screw propeller, laid the foundations for our present maritime developments.

Succeeding chapters deal with refinements in the design of stationary engines and boilers, portable sets, locomotives, and marine engines up to the date of the first edition, 1878. A later chapter brings this review up to the end of the nineteenth century. It is curious that while Dr. Thurston considers the rotary engine, he makes no reference to the possible development of the steam turbine.

The author presents the "Philosophy of the Steam Engine" in two chapters where he briefly outlines the development of the principles of thermodynamics and the requisites for successful design and operation of engines and boilers. These chapters are distinguished by a remarkable clarity of analysis and deduction in view of subsequent developments.

The last chapter, added by the present director of Sibley College, Prof. W. N. Barnard, reviews in a clear and lucid manner the developments which have occurred in the present century and thus brings the story of steam development up to the present.

The text is free from mistakes. Dr. Thurston writes in a style that makes the book easy and delightful reading. One can strongly recommend every engineer to read this interesting book in order to obtain a true appreciation of the great work of his pioneer predecessors in the profession. To the engineering student "A History of the Growth of the Steam Engine" should be his first choice of supplementary reading to required textbooks.

Books Received in Library

ABSORPTION SPECTROPHOTOMETRY and Its Applications; Bibliography and Abstracts 1932 to 1938. By O. J. Walker. Adam Hilger, Ltd., London, England, 1939. Linen, 6 × 10 in., 68 pp. A comprehensive list of references covering the developments and applications of absorption spectrophotometry for the period 1932 to 1938. To facilitate the task of obtaining quantitative absorption data concerning any particular problem, the references have been classified under various general headings and are numbered serially. There is an author index.

APPLIED AERODYNAMICS. By L. Bairstow. Second edition. Longmans, Green & Co., New York, N. Y., and London, England, 1939. Cloth, 6 × 9 in., 808 pp., illus., diagrams, charts, tables, $18.50. Aerodynamics as applied to aeronautics constitutes the subject of this comprehensive work and, although not directly a treatise on aeroplane design, a substantial account is presented of the methods of attacking problems arising from the motion of aircraft. Following an introductory chapter which outlines the growth of aeronautics there is a description of the principles of flight. Methods of measurement, laboratory tests, the effects of aerial maneuvers, and dynamical similarity are discussed. The most important chapters deal exhaustively with theories of fluid motion as applied to aeronautics, including an analysis of airscrews, and the prediction of airplane performance and the stability of aircraft are also considered.

A.S.T.M. STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS, prepared by Committee D-2. September, 1939. Methods of Testing, Specifications, Definitions, Charts, and Tables. American Society for Testing Materials, Philadelphia, Pa., 1939. Paper, 6 × 9 in., 336 pp., illus., diagrams, charts, tables, $2 ($1.50 to members). This pamphlet is a compilation of various A.S.T.M. standard and tentative specifications for petroleum products and lubricants, consisting mainly of determinative test methods and analyses of the materials in question. Two groups of standard definitions of terms relating to petroleum and to materials for roads and pavements are also included.

A.S.T.M. STANDARDS ON TEXTILE MATERIALS, prepared by Committee D-13. October, 1939. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 324 pp., illus., diagrams, charts, tables, $2 ($1.25 to members). Definitions and terms, methods of testing, and specifications for asbestos, cotton, jute, rayon, wool, and textiles in general are given. Additional material, appearing in appendixes, include photomicrographs of textile fibers, tables for yarn-number conversion and relative humidity, a glossary of terms (not standard, for information only), and abstracts of papers presented at committee meetings.

ATM (Archiv für technisches Messen) Lieferung 97 and 98, July and August, 1939. R. Oldenbourg, Munich and Berlin, Germany. Paper, 8 × 12 in., pp. T 85–112, illus., diagrams, charts, tables, 1.50 rm each. Two numbers of a monthly publication containing classified articles upon various types of apparatus and methods for technical measurements. Certain numbers also contain descriptions of specific instruments manufactured by German companies.

DIE-CASTINGS. By A. Street. Emmott & Co., Ltd., London, England, 1939. Cloth, 5 × 8 in., 160 pp., illus., diagrams, tables, 4s, 6d. Intended particularly as a source of information for users of die castings, this small volume describes briefly the methods and materials for die-casting work. Some technical problems are considered, the factors which make for the best results are explained, and a bibliography is included for those who wish to investigate any part of the subject in more detail.

ELECTRIC POWER ENGINEERS' HANDBOOK. By W. S. Ibbetson. Chemical Publishing Co., New York, N. Y., E. & F. N. Spon, London, England, 1939. Cloth, 6 × 9 in., 241 pp., illus., diagrams, charts, tables, $5. Intended as a practical manual for the efficient control and care of all kinds of electrical machinery, this book presents basic theory, description, and directions for the proper operation and maintenance of motors, generators, converters, and rectifiers. There are two chapters on faults, breakdowns, and testing.

EMAILTECHNIK. By L. Vielhaber. V.D.I. Verlag, Berlin, Germany, 1939. Paper, 6 × 8½ in., 146 pp., illus., diagrams, charts, tables, 9 rm. The composition and use of enamels are considered, beginning with the raw materials, types of enamels, and manufacturing processes. Mechanical, thermal, chemical, and optical properties are discussed both for enamels and enameled coatings. The application, dyeing, and firing of enamels on sheet steel and cast iron are described, including operation, control, and likely errors.

LES FLUCTUATIONS ÉCONOMIQUES ET L'INTERDÉPENDANCE DES MARCHÉS. By B. Chait. R. Louis, Rue Borrens 37–39, Brussels, Belgium, 1938. Cloth and paper, 6 × 10 in., 344 pp., diagrams, charts, tables, cloth, 150 fr, Belgian; paper, 135 fr Belgian. The author examines the subject of economic fluctuations, establishes certain quantitative criteria for the stability of price systems, and derives a general law to explain shifts in prices, from which he draws certain basic conclusions with regard to our economic mechanism. Numerous graphs accompany the text, and a glossary of terms, a list of symbols, and a bibliography are appended.

Great Britain. Department of Scientific and Industrial Research. Methods for the Detection of Toxic Gases in Industry. Leaflet No. 6, CARBON-BISULPHIDE VAPOR. His Majesty's Stationery Office, London, England, 1939. Paper, 6 × 10 in., 8 pp., diagrams, tables. (Obtainable from British Library of Information, 50 Rockefeller Plaza, New York, $0.10.) The properties, occurrence, poisonous effects, and first-aid treatment are briefly mentioned, in addition to the description of the methods and equipment for carrying out the test for carbon-bisulphide vapor.

HISTORY OF THE GROWTH OF THE STEAM-ENGINE. By R. H. Thurston. Centennial edition with a supplementary chapter by W. N. Barnard. Cornell University Press, Ithaca, N. Y., 1939. Cloth, 5¼ × 7¾ in., 555 pp., illus., diagrams, charts, tables, $3. In commemoration of the centenary of Thurston's birth, his classic treatise has been republished from the plates of the 1907 edition. A final chapter by Prof. William N. Barnard supplies a brief supplementary history of steam-power engineering from 1870 to 1939.

BUCH VOM SPANNEN. By P. Forkardt Kommanditgesellschaft, Düsseldorf. Julius Springer, Berlin, Germany, 1939. Cloth, 8 × 12 in., 219 pp., illus., diagrams, tables, 15 rm.

The chucking and other holding devices manufactured by the Forkardt firm are pictured and described fully, with general information about requirements, methods, operating details, and design. There are alphabetical indexes of chuck types and workpieces to be handled, and a list of catchwords with brief explanations of the important ones.

COMBATING CORROSION in Industrial Process Piping. By L. G. Vande Bogart. Crane Co., Chicago, Ill., May, 1939. Paper, 8 × 11 in., 103 pp., illus., charts, tables, $3. Corrosion theory is discussed, both for direct chemical corrosion, such as oxidation, and for electrochemical corrosion; the behavior of common piping materials, both metallic and nonmetallic, in contact with typical corrosive solutions is considered; and the practical problem of corrosion is treated under classified groups of corrosive liquids. There is a bibliography and a list of recommendations of materials, arranged alphabetically by corrosive agents.

DEUTSCHE KRAFTFAHRTFORSCHUNG im Auftrag des Reichs-Verkehrsministeriums. V.D.I. Verlag, Berlin, Germany, 1939. Paper, 8 × 12 in., illus., diagrams, charts, tables. Heft 26, Rollwiderstand von Luftreifen, by H. Kluge and E. Haas, 10 pp., 1.15 rm. Heft 27, Korrosionsangriff durch Kraftstoffe, by M. Marder and H. Farnow, 15 pp., 1.70 rm. Heft 28, Gewinde in Leichtmetall, by E. Lippert, 42 pp., 4.50 rm. Heft 29, Zylinder- und Kolbenringverschleiss, by G. Beck, 11 pp., 1.20 rm. Heft 30, Nickelfreie Baustähle, by W. Eilender, H. Cornelius, and H. Arend, 11 pp., 1.25 rm. Heft 31, Messung der Klopffestigkeit an Otto-Motoren, by R. Schütz, 22 pp., 2.25 rm. The topics covered by these six German automotive-research publications are as follows: 26, investigations of the rolling resistance of pneumatic tires; 27, corrosion attack by motor fuels; 28, influence of tolerance allowance on the holding power of light-metal-alloy screw threads; 29, cylinder and piston-ring wear; 30, nickel-free alloy steels as substitutes for nickel steels in structural work; 31, measurement of the knock characteristics of Otto-cycle engines.

DIESEL ENGINEERING HANDBOOK 1939–1940, de luxe edition, edited by L. H. Morrison. Diesel Publications, New York, N. Y., 1939. Cloth, 6 × 9 in., 940 pp., illus., diagrams, charts, tables, $6. This handbook, revised and enlarged, provides much practical up-to-date information upon the operation and maintenance of Diesel engines, valuable both to the owner and operator. The treatment is exhaustive and profusely illustrated from actual practice. Two chapters of engineering fundamentals are devoted to brief description of useful general engineering terms and equipment.

DRILLING and PRODUCTION PRACTICE, 1937, 1938. Two volumes. Sponsored by the Central Committee on Drilling and Production Practice of the American Petroleum Institute, New York, N. Y., 1938–1939. Cloth, 8 × 11 in., illus., diagrams, charts, tables; 1937, 446 pp., $3; 1938, 458 pp., $3. The American Petroleum Institute annually publishes these collections of selected papers on drilling and production practice presented at its meetings. The papers are divided into four groups: drilling practice, production practice, materials, and miscellaneous. A bibliography of district-meeting papers, following the main text, contains abstracts and references as to where the complete papers have been published.

HUMAN-RELATIONS MANUAL FOR EXECUTIVES. By C. Heyel. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1939. Cloth, 5 × 8 in., 253 pp., diagrams, charts, tables, $2. Hundreds of ideas for selecting, developing, stimulating, safeguarding, and guiding the working force are presented in the form of case examples of what actual companies are doing successfully to solve their personnel problems. Application check points, consisting of pertinent questions on the preceding material, accompany each chapter.

MACHINE SHOP WORK. By F. W. Turner and O. E. Perrigo, revised by A. Bertrand. American Technical Society, Chicago, Ill., 1940. Cloth, 6 × 9 in., 361 pp., illus., diagrams, charts, tables, $2.75. This comprehensive treatise on approved shop methods includes the construction and use of tools and machines, details of their efficient operation, and a discussion of modern production methods. Descriptive illustrations and diagrams are used extensively and there is a final chapter explaining typical slide-rule calculations.

MAGNESIUM UND SEINE LEGIERUNGEN. Prepared by H. Altwicker and others, edited by A. Beck. Julius Springer, Berlin, Germany, 1939. Cloth, 6 × 9½ in., 520 pp., illus., diagrams, charts, tables, paper, 54 rm; cloth, 56.70 rm. This comprehensive handbook, which aims to summarize our knowledge of the physical and technological properties of magnesium and its alloys, is the product of various specialists connected with the Elektrometall division of the I. G. Farbenindustrie Aktiengesellschaft. The opening section describes magnesium ores and the production of magnesium. The physical properties and metallography of the metal and its alloys, and their mechanical and chemical properties are discussed at length. Methods of melting, casting, and working are described, as well as its use as an alloying element and in pyrotechnics and thermochemistry. A chapter is devoted to chemical analysis and another to a useful list of American and foreign patents.

MARINE DIESEL MANUAL, edited by L. R. Ford; produced and distributed by Diesel Publications, New York, N. Y., 1939. Paper, 5 × 6 in., 207 pp., illus., diagrams, charts, tables, $0.50. This brief practical manual covers the principles, types, and details of marine Diesel engines, including fuel systems, lubrication, operation and maintenance instructions, auxiliary equipment, and electric and gear drives.

MATTER AND LIGHT, the New Physics. By L. de Broglie; translated by W. H. Johnston. W. W. Norton & Co., New York, N. Y., 1939. Cloth, 5 × 9 in., 300 pp., diagrams, tables, $3.50. In this volume the distinguished French physicist has collected a number of studies on contemporary physics written both from the general and the more metaphysical point of view. The subjects include: a general survey of contemporary physics; matter and electricity; light and radiation; wave mechanics; philosophical studies on quantum physics; and philosophical studies on various subjects. Except in two chapters, the reader requires no mathematics.

MODERN BLAST CLEANING AND VENTILATION. By C. A. Reams. Penton Publishing Co., Cleveland, Ohio, 1939. Cloth, 6 × 9½ in., 213 pp., illus., diagrams, charts, tables, $4. The whole field of blast cleaning of metallic surfaces is surveyed from a practical viewpoint. Both compressed air and centrifugal methods are considered, including equipment, procedures, proper conditions, and protective devices. The use of surface blasting for increasing the fatigue resistance of metal is discussed, and the subjects of ventilation, maintenance, and selection of equipment receive attention. Various specific types of jobs are described and there is a list of uses for blast-cleaning equipment.

ORGANIZATION AND MANAGEMENT OF PRODUCTION. By W. N. Mitchell. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1939. Cloth, 6 × 9½ in., 417 pp., diagrams, charts, tables, $4. In this text the author presents the outgrowth of his attempts to develop an introductory course in production management for business students in colleges. The book deals concisely with those factors in the economic, technological, and geographical environment of production that determine the general forms of organization of production activities, and also covers the more important problems encountered by production executives in administration work. Reference lists, questions, and exercises are appended.

OPERATION ANALYSIS. By H. B. Maynard and G. J. Stegemerten. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1939. Cloth, 6 × 9 in., 298 pp., illus., diagrams, charts, tables, $3. The authors present practical methods of analyzing operations and determining more efficient, economical, and labor-saving procedures which can be applied by any shop supervisor. The different steps are developed systematically and in detail, from the preliminary consideration of the job to the final establishment of the best procedure. The methods are illustrated by numerous examples from many types of industries.

PATENT FUNDAMENTALS. By A. Schapp of Schapp & Cole, San Francisco, Calif. Industrial Press, New York, N. Y., 1939. Cloth, 5 × 9 in., 176 pp., diagrams, $2. A nontechnical explanation of what constitutes true invention is given, with practical examples. Other topics covered include procedure in obtaining adequate patent protection, drafting of effective claims, making assignments, and issuing licenses. Essential facts about trademarks and copyrights are presented.

PETROLEUM TECHNOLOGY, Annual Reviews, vol. 4 (covering 1938), edited by F. H. Garner. Institute of Petroleum, London, England, 1939. Cloth, 6 × 9 in., 478 pp., illus., diagrams, charts, tables, 11s. This annual compilation contains reviews by experts of developments within 1938 in the whole range of petroleum technology: geology, geophysics, drilling and production, transportation and storage, refinery operations, fuel oils, gasoline and oil engines, lubrication, road materials, analysis, and testing. In addition to chapter bibliographies there is a general review of petroleum literature in 1938, and the last chapter furnishes production and commercial statistics.

PIONEERS OF PLENTY, the Story of Chemurgy. By C. Borth. Bobbs-Merrill Co., Indianapolis, Ind., and New York, N. Y., 1939. Cloth, 6 × 9 in., 303 pp., illus., $3. The growth of "chemurgy," the science of turning surplus or waste material into useful products through mechanical and chemical processes, is described in this work. The author describes the work of the important men in the field, the processes which have been developed, and the resulting products; paper pulp from cheap timber and the great number of synthetic drugs, fabrics, and plastics of the present day.

POWER ECONOMICS FOR ENGINEERING STUDENTS. By R. C. Gorham. Pittsburgh Printing Co., Pittsburgh, Pa., 1939. Cloth, 6 × 9½ in., 310 pp., diagrams, charts, tables, $3.25. The necessity for engineering economy

is stressed in part A, which presents fundamental concepts and factual information, with general principles which are applicable to engineering practices for best over-all economy. Part B furnishes the opportunity for the application of the preceding principles, largely through the use of examples from public-utility practice. There are lists of references and many problems.

PRACTICAL MANUAL OF CHEMICAL ENGINEERING. By H. Tongue, with a foreword by Sir G. Morgan. D. Van Nostrand Co., New York, N. Y., 1939. Cloth, 6 × 10 in., 560 pp., illus., diagrams, charts, tables, $12. The first four chapters are devoted to the metals used in the chemical industries and describe their properties at high and low temperatures and the methods of joining them for the construction of equipment. Chapter 5 covers the nonmetallic materials of construction. The succeeding eleven chapters deal with steam plants for chemical works and such processes as evaporation, drying, distillation, filtration, pumping, crushing, and grinding, with considerable emphasis on the design and construction of process equipment. An appendix treats of the safety aspects of plant design and operation.

PRINCIPLES OF INDUSTRIAL ORGANIZATION. By D. S. Kimball and D. S. Kimball, Jr. Fifth edition, McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1939. Cloth, 6 × 9 in., 478 pp., illus., diagrams, charts, tables, $4. The internal organization and procedures of industrial enterprises are comprehensively covered, and industrialism is considered from the broader points of view of economic organization in general. New material treating of the effect of recent Federal legislation upon industry has been included in this new edition, and all statistical data have been revised.

PRINCIPLES OF METALLOGRAPHY. By R. S. Williams and V. O. Homerberg. Fourth edition, McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1939. Cloth, 5½ × 8½ in., 339 pp., illus., diagrams, charts, tables, $3.50. This standard elementary text has been extensively revised and a new chapter on the plastic deformation and annealing of metals has been added. As before, the alloy diagram and its meaning are explained; iron, steel, and the important nonferrous metals are described, including the physical changes resulting from heat-treatment; and both macroscopic and microscopic methods of examination are described. Tables of etching solutions and reagents are appended.

PRODUCTION MANAGEMENT. By A. M. Simons, reviewed by H. P. Dutton. American Technical Society, Chicago, Ill., 1940. Cloth, 6 × 9 in., 588 pp., illus., diagrams, charts, tables, $3.50. The efficient control of present-day mass production is possible only through the standardization of the many procedures which contribute to it. The intention of this book is to provide a practical approach to the problems of plant location, factory layout, work routing, task fixing, office organization, and to the many phases of hiring, training, and handling of the personnel.

PUBLIC SPEAKING FOR TECHNICAL MEN. By S. M. Tucker. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1939. Cloth, 6 × 8 in., 397 pp., $3. The proper presentation of speeches, lectures, and so on, is comprehensively covered. Virtues and defects in speaking are brought out through narrative treatment, and working principles to be drawn from these examples are conveniently summarized at the end of chapters. The subject matter covers not only diction, organization of material, and platform technique, but also important helps for the technical speaker on using charts and answering questions.

SCHRIFTEN DER DEUTSCHEN AKADEMIE DER LUFTFAHRTFORSCHUNG, Heft 9, 1939. Deutsche Akademie der Luftfahrtforschung, Berlin. R. Oldenbourg, Munich and Berlin, Germany. Cloth, 7 × 10 in., 415 pp., illus., diagrams, charts, tables, 30 rm. On the occasion of the fifth public session of the German Academy for Aeronautical Research fifteen papers were presented on the physical and chemical processes of combustion in internal-combustion engines. This compilation contains these papers and the ensuing discussions, and also has brief bibliographies of the authors.

SCIENCE TODAY AND TOMORROW. By W. Kaempffert. The Viking Press, New York, N. Y., 1939. Cloth, 5 × 8½ in., 275 pp., tables, $2.50. The great events on the horizon of science in the fields of astronomy, physics, chemistry, biology, electricity are presented in nontechnical language. In addition to his exposition of these developments, the author ventures to predict some probable or possible future extensions and their influence on the social organization.

STOKER HANDBOOK. By H. D. Airesman. J. B. Lippincott Co., New York, N. Y., and Philadelphia, Pa., 1939. Cloth, 5 × 8 in., 201 pp., illus., diagrams, charts, tables, $3. This manual describes the installation, operation, and maintenance of domestic and small commercial stokers in simple, practical fashion. Both bituminous and anthracite stokers are included, and the information covers applications to hot-water, warm-air, and steam heating plants.

TECHNISCHE STATIK, ein Lehrbuch zur Einführung ins technische Denken. By W. Schlink and H. Dietz. Julius Springer, Berlin, Germany, 1939. Cloth, 7 × 10 in., 386 pp., diagrams, charts, tables; cloth, 29.40 rm; paper, 27.60 rm. The analysis of forces operating in both plane and space frameworks is comprehensively presented, with a profusion of explanatory diagrams. Practice problems with fully worked-out solutions are included for each chapter.

TECHNOLOGY AND LABOR. By E. D. Smith and R. C. Nyman. Institute of Human Relations, Yale University Press, New Haven, Conn., 1939. Cloth, 6 × 10 in., 222 pp., $2.50. This "study of the human problems of labor saving" is based upon first-hand observations in Southern cotton mills where the "extended labor" system was being introduced. The difficulties encountered, the ways in which they were overcome, and the effects of the changes in method, both temporary and lasting, are discussed.

V.D.I.-Forschungsheft 397, July-August, 1939. Ausfluss- und Kraftmessungen an der Beschauflung einer einstufigen Versuchsturbine im Luftversuchsstand, by W. Hartmann. V.D.I. Verlag, Berlin, Germany. Paper, 8 × 12 in., 20 pp., illus., diagrams, charts, tables, 5 rm. This research report describes the setup, procedure, theoretical basis, and results of tests on discharge and power measurements in the blading of an experimental single-stage turbine. The test data are presented in numerous graphs and tables.

VORGÄNGE UND FESTIGKEITEN BEIM HARTLÖTEN. By O. Fischer. V.D.I. Verlag, Berlin, Germany, 1939. Paper, 6 × 9 in., 40 pp., illus., diagrams, charts, tables, 3.75 rm. This is a first report upon a series of investigations of solders, undertaken to ascertain the best methods of use and to obtain accurate figures for the strength of soldered joints. The available data upon the strength of solders are collected and reported, and in addition the results of tests of the strength of hard soldering of steel.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretation of this Committee formulated at the meeting of December 1, 1939, which was subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE NO. 887

(Interpretation of Par. U-13d)

Inquiry: Table U-3 allows a working stress of 10,000 lb for grades B and B2 of Specification S-11 for Carbon Steel Castings. Par. U-13*d* of the Code allows a stress for cast steel of 7000 lb per sq in. Should not the wording of Par. U-13*d* be altered?

Reply: When Table U-3 was adopted the last sentence of Par. U-13*d* should have been deleted. It was intended that when cast steel is used the stresses provided for in Table U-3 be allowed.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

1940 A.S.M.E. Spring Meeting to Be Held in Worcester, Mass., May 1–3

National Meeting of the Society to Feature Technical Papers, Plant Visits, and Entertainment

WORCESTER, which was the scene of the Spring Meeting of The American Society of Mechanical Engineers in 1918, will be host again to members of the Society for the 1940 Spring Meeting, scheduled to be held May 1–3, 1940. The 1918 meeting, as reported in *The Journal of the A.S.M.E.*, "was great in attendance, with a total registration of 986—the biggest Spring Meeting ever held by the Society; it was great in practical accomplishment in the interests of the Society and its work; and it was great in the good fellowship and hospitality displayed by the citizens of Worcester and provided for with such admirable care by the members of the local committee." As in 1918, the Bancroft Hotel, entirely modernized, will serve as headquarters and provide facilities for the technical meetings as well as the social functions.

Sometimes, Worcester is called the "city of diversified industries." It has the largest population of any manufacturing city in the country not on a waterway. Other industrial distinctions claimed include 500 manufacturing establishments, some of which are the largest in their line in the country and, in some cases, in the world. Some of the products made there are abrasives, cold-rolled strip steel, crankshafts, machine tools, metal stampings, rolling-mill machinery, textile machinery, screw-machine products, sprinkler systems, trolley and railroad cars, wire goods, wrenches, and valentines. Also located in this city of New England is Worcester Polytechnic Institute which contains the world-famous hydraulic laboratory.

Local Committee at Work

Since the summer of 1939, a local committee has been hard at work to outdo in every way the success of the 1918 meeting by preparing a program that should attract hundreds of engineers, not only from New England but also from other parts of the country. Prof. Charles M. Allen, past vice-president A.S.M.E., heads the committee as chairman, and Ralph F. Gow is vice-chairman. Other members of the committee include the following subcommittee chairmen: R. P. Kolb, technical papers; O. B. Denison, hotel and entertainment; Robert Erickson, publicity; F. H. Daniels, reception; C. P. Howard, plant trips; and A. J. Gifford, finance. Others who are doing their part are the members and juniors of the Worcester Section and the student members at Worcester Polytechnic Institute.

WORCESTER (MASS.) MEMORIAL AUDITORIUM

AERIAL VIEW OF NORTON COMPANY FACTORIES, WORCESTER, MASS., TO WHICH TRIP IS PLANNED DURING A.S.M.E. 1940 SPRING MEETING

Program Features

Already plans are so far advanced that the local committee reports the scheduling of 14 technical sessions at which 25 or more papers will be presented on such subjects as iron and steel, steam power, machine-shop practice, fuels, management, hydraulic, heat transfer, and materials handling. Other functions beside technical meetings will include visits to the John Woodman Higgins Armory, the windowless plant of the Simonds Saw Co., Norton Co., Leland-Gifford Co., Crompton & Knowles Loom Works, the hydraulic laboratory and shops at Worcester Polytechnic Institute, Rockwood Sprinkler Co., American Steel & Wire Co., and others. Entertainment will feature such attractions as luncheons, a reception, formal dinner, and golf, facilities for which will be available every day of the meeting.

Technical Papers

One of the interesting things about this meeting is that the majority of the technical papers are being presented by engineers from

Worcester and the State of Massachusetts. Some of these papers and authors are: "From the Anvil to the Press," by John W. Higgins, president, Worcester Pressed Steel Co.; "Modern Metal Forming," by Harold T. Burke, chief tool designer, Worcester Pressed Steel Co.; "Deep Drilling," by an engineer of the Leland-Gifford Co.; "The Use of High-Speed Photography in the Study of Machine Motions," by Victor Sepavich, Crompton & Knowles Loom Works; "Industrial Steam Power," by W. F. Ryan, Stone & Webster Engineering Corp.; "Powdered Coal and Stoker Firing Compared for Medium-Sized Boilers," by Ollison Craig, engineering manager, Riley Stoker Corp.; "Low-Velocity Characteristics of the Salt-Velocity Method," by L. J. Hooper, Worcester Polytechnic Institute; "Properties of Hydrogen Mixtures," by A. W. Bruno, General Electric Co.; "Modern Developments in Materials Handling," by Russell Hastings, chief engineer, Lewis-Shepard Sales Corp.; "Factors in the Fatigue of Helical Springs," by R. R. Tatnall, Wickwire-Spencer Steel Co.; and "Progress Report on Cavitation Testing of Materials," by B. G. Rightmire, M.I.T.

An international flavor is being added to the technical program by the inclusion of a paper on "Experimental Drying," by Dr. D. L. Cooper, Fisheries Research Bureau, Halifax, Nova Scotia, and a paper on "Comparative Tests of Flow Measurements," by O. H. Dodkin, of Brazil, South America. There are several other papers, now being arranged, which will be presented.

HOTEL BANCROFT, WORCESTER, MASS.
(Headquarters for 1940 A.S.M.E. Spring Meeting.)

1940 A.S.M.E. Membership List to Be Mailed in February as a Section of Transactions

Also Contains Personnel of Committees for Year and a New Professional-Service Index

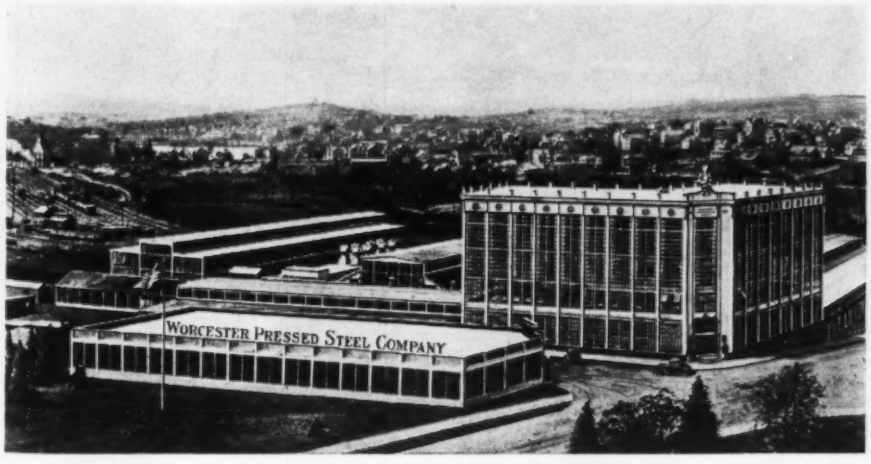
THE 1940 A.S.M.E. Membership List, the first to be issued since 1937, is almost completed and will be ready for mailing to A.S.M.E. members on and after Feb. 10, 1940, as a section of the February issue of the Transactions. Approximately 14,000 members, in good standing as of Dec. 1, 1939, and living in the United States, Canada, Newfoundland, Mexico, Central America, West Indies, South America, Africa, Asia, Europe, and Oceania, are listed alphabetically as well as geographically. A special listing of more than 5600 student members is also included.

Committee Lists

The front portion of the book contains Part I of the Society Records for 1939–1940, which includes names and portraits of officers and members of Council, a complete list of standing and technical committees, local sections, and professional divisions, descriptions and recipients of honors and awards of the A.S.M.E., a list of honorary members and past-presidents, and an index to this portion. There is a compilation of colleges and universities at which A.S.M.E. Student Branches are located, together with the names of the chairmen, secretaries, and honorary chairmen. And for the first time in the history of the A.S.M.E., the names of officers of the Junior Groups of the Society will be included.

Professional Service Index

The 1940 Membership List inaugurates a new section, called a Professional Service Index, which groups geographically about 700 A.S.M.E. members engaged in independent consulting practice, as compiled from the special reply cards sent with the Membership List card to the members in the early part of October, 1939. The Index is confined to consultants, either as individuals or those connected with consulting organizations, and is made up of consulting engineers, management consultants, specialists, patent attorneys and agents, constructors, and contractors. Only those rendering service independent of or uninfluenced by the manufacture or sale of a product are being listed. Any omissions are due in most part to failure on the part of members to return the reply card or to furnish the information requested. Supplementing this Index and immediately following it, is a classified specialty list of approximately 60 of the consultants, who have paid to have their specialized lines of practice noted.



TRIP IS PLANNED TO WORCESTER PRESSED STEEL COMPANY DURING A.S.M.E. SPRING MEETING IN WORCESTER, MASS.

Railroad Division Holds Eighth Annual Dinner

THE Railroad Division held its eighth annual dinner in the Pink Room of the Bellevue-Stratford, Philadelphia, Pa., Thursday, Dec. 7, 1939. Dr. W. H. Winterrowd, vice-president, The Baldwin Locomotive Works, Philadelphia, Pa., represented the President of the Society in the installation of the incoming Division chairman, Lawford H. Fry, railway engineer, Edgewater Steel Co., Pittsburgh, Pa. The retiring chairman, C. T. Ripley, chief engineer, technical board of the Wrought Steel Wheel Industry, Chicago, Ill., was presented with a past-chairman's certificate. The installation ceremonies were brought to a close with the introduction of the new member to the Division's Executive Committee, John G. Adair, mechanical engineer, Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C.; and of the three new members of the Division's General Committee, L. B. Jones, engineer of tests, Pennsylvania Railroad, Altoona, Pa., R. W. Salisbury, mechanical engineer, Texas & Pacific, Dallas, Tex., and Dennistoun Wood, engineer of tests, Southern Pacific, San Francisco, Calif. There was a total attendance of 26.

The annual dinner of the Railroad Division has had an unfortunate conflict for the last four years with the annual dinner of the New York Railroad Club. This larger affair has reduced the attendance at the annual Railroad Division dinner. Because of the small attendance this year only routine reports were presented. It was decided to present the problem to the Meetings and Program Committee of the Society and endeavor to have the railroad

sessions at the Annual Meeting and annual dinner scheduled for some other day during the week than Thursday. It was also decided to reduce the terms of those serving on the General Committee RR2 from five to three years, and to subject the membership of this committee to annual review by the Executive Committee RR1 to insure maintenance of interest and activity.

A meeting of the Executive Committee was held during the lunch hour, Thursday, December 7, at which meeting Maurice C. Swanson, American Locomotive Co., Schenectady, N. Y., was elected junior assistant to the Railroad Division. It is planned to have Mr. Swanson assist the division secretary, M. B. Richardson, through whose cooperation this account was prepared.

The Nominating Committee Urges Members to Suggest Nominees for Office in 1941

Preferably Not Later Than April 1, 1940

THE 1940 Nominating Committee urges the members of the Society to give serious consideration to the selection of nominees for elective offices in 1941 and to submit their suggestions promptly, preferably not later than April 1, 1940.

The offices to be filled are President, three Vice-Presidents to serve two years, and three Managers to serve three years. The Constitution, By-Laws, and Rules of the Society, Articles C7, B7, and R7, govern the election of directors.

Forms to Be Furnished

At its organization meeting in December, the Nominating Committee agreed to draft a form indicating to suggesters, the information the Committee feels essential to full consideration of each proposed nominee. The sponsor will be asked to submit seven complete copies of the proposed candidate's biographical and professional record. This record should present a list of the activities of the proposed nominee within the Society as well as in other professional and nonprofessional organizations. The candidate's sponsor should also obtain preliminary assurance of willingness and freedom to serve if elected.

National professional prominence and leadership are essential to able officers of the Society. Knowledge of Society affairs and management obtained by previous service on committees is important to enable the successful candidate to render service to the best of his real ability. The nominees for president and vice-presidents must be of the member or fellow grade; managers may be of any grade of membership.

At the organization meeting of the 1940 Nominating Committee on December 6, 1939, Prof. O. A. Leutwiler was elected chairman and A. R. Mumford was elected secretary. Some members of the Society took advantage of the scheduled open hearing immediately after the organizing meeting to propose nominees for office. The Committee decided to hold its final executive session during the Semi-Annual Meeting of the Society, June 17 to 21, at Milwaukee, Wis. On Tuesday, June 18, of that week an open meeting will be held at which time it is hoped that any member of the Society who desires to appear personally before the Committee, to express his views or discuss any matters pertaining to nominations, will do so. The hours of the Committee's open meeting will be from 10:00 a.m. to 4:00 p.m. on Tuesday, June 18, 1940, at the Milwaukee headquarters.

It is highly desirable that representative regional groups make every effort to learn the desires of the membership in their region and convey those desires by mail or in person to the Committee through the regional representative.

Emphasis cannot be too heavily placed on the desirability of furnishing the Committee with seven copies of the full and complete record of the proposed nominee. Copies of the suggested information form may be obtained from the Secretary as soon as they are available.

Group	Representative	Alternate
I	E. R. Fish Boiler Inspection & Insurance Co. 56 Prospect St., Hartford, Conn.	W. F. Ryan (1st) Stone and Webster Corp. 49 Federal St., Boston, Mass. F. O. Hoagland (2nd) 210 Four Mile Road, West Hartford, Conn.
II	A. R. Mumford Consolidated Edison Co. of New York 4 Irving Place, New York, N. Y.	E. J. Billings Babcock & Wilcox Co. 85 Liberty St., New York City
III	D. G. Williams 118 South 16th St., Allentown, Pa.	A. L. Kimball (1st) General Electric Co. Schenectady, N. Y. F. C. Spencer, Jr. (2nd) 620 Shadowlawn Drive, Westfield, N. J.
IV	K. P. Kammer New Orleans Public Service, Inc. 317 Baronne St., New Orleans, La.	E. E. Williams (1st) Duke Power Co. Charlotte, N. C. W. R. Chambers (2nd) Tenn. Valley Authority Knoxville, Tenn.
V	C. M. Gross Delco Remy Anderson, Ind.	Warner Seely Warner and Swasey Co. 5701 Carnegie Ave., Cleveland, Ohio
VI	O. A. Leutwiler Univ. of Illinois Urbana, Ill.	H. B. Bernard (1st) Sinclair-Prairie Oil Co. Sinclair Bldg., Tulsa, Okla. L. P. Weiner (2nd) Hiram Walker and Sons, Inc. Ft. of Edmund St., Peoria, Ill.
VII	B. T. McMinn University of Washington Seattle, Wash.	Ralph L. Dyer (1st) Natl. Bank of Commerce Bldg. 1110 2nd Ave., Seattle, Wash. E. O. Eastwood (2nd) University of Washington Seattle, Wash.

Index to Mechanical Engineering

As part two of the January, 1940, issue of the Transactions of the A.S.M.E., separate indexes to the Transactions and to MECHANICAL ENGINEERING for 1939 were mailed to the A.S.M.E. membership.

An additional copy of the index to MECHANICAL ENGINEERING may be secured from A.S.M.E. Headquarters, 29 West 39th Street, New York, N. Y., by sending ten cents for handling changes.

Committee on Local Sections Celebrates Twenty-Fifth Anniversary at Dinner

Col. E. H. Whitlock, First Chairman, and Ernest Hartford, Secretary, Are Honored

TIME stood still for a moment on the evening of Dec. 4, 1939, when the past and present members of the Committee on Local Sections celebrated the twenty-fifth anniversary of its founding with a dinner in the Rittenhouse Club, Philadelphia, Pa. Old times and the embryonic activities of the Committee were recalled when a testimonial of esteem and appreciation in the form of a special booklet was presented to Col. Elliott H. Whitlock, first chairman of the Committee, which was formed by action of Council in December, 1914. The toastmaster and retiring chairman of the 1939 Committee, D. B. Prentice, sprang a surprise by reading a biography of Ernest Hartford, the first and present secretary of the Committee. Finally, Dean Prentice was inducted into the "Association of Local Sections Committeemen," a group of past-chairmen of the committee.

In his testimonial booklet, Colonel Whitlock is reminded how the first committee was formed in 1914 and consisted of (besides himself) D. Robert Yarnall, W. F. M. Goss, L. C. Marburg, and Walter Rautenstrauch. The 11 sections existing at that time consisted of the following, showing year of organization: 1904, Milwaukee; 1909, St. Louis; 1910, New York (Metropolitan), San Francisco; 1912, Cincinnati, New Haven, Philadelphia; 1913, Atlanta, Chicago, and Minneapolis and St. Paul (Minnesota). During his term of office, the following Sections were founded: 1915, Birmingham, Buffalo, Los Angeles, Worcester; 1916, Baltimore, Detroit, Indianapolis, and New Orleans. Beside a biographical sketch of his life, the booklet contains a composite photograph showing Colonel Whitlock at various ages, starting as early as 1884 while he was a student at Texas A.&M. College.

More Than 275 Bridgeport Engineers Meet on Dec. 14

Bridgeport Section had one of the best meetings in history when more than 275 engineers turned out for the Dec. 14 meeting which was held in the Stratfield Hotel. According to the report received from William H. Sniffen, secretary of the Section, Edward Dennison, engineer in charge of Diesel-engine tests, Electric Boat Company, gave an excellent talk on Diesel engines and their use in power stations, submarines, boats, airplanes, and automobiles. He was followed by Capt. W. W. Foster, in charge of submarine testing for the company, who described the technical, as well as the exciting, features of his job. The third speaker, who was not scheduled on the program was none other than Simon Lake, 85-year-old submarine designer and builder. Particularly interesting was Mr. Lake's account of his work with Dr. Rudolf Diesel.

Dr. C. G. Abbot Talks to 300 Buffalo Members and Guests

The sun and the weather were the topics discussed by Dr. C. G. Abbot, secretary of the Smithsonian Institution, Washington, D. C., in a talk presented before 70 members and 230 guests of the Buffalo Section on Dec. 15, 1939.

Membership Dues as a Business Expense Not Taxable

Members of The American Society of Mechanical Engineers engaged in professional work are reminded that their membership dues, as a business expense, are ordinarily deductible in arriving at their taxable net income.

Colorado Section Hears Minerals Key to Power

Approximately 35 members of Colorado Section attended the Dec. 15 meeting to hear C. E. Dobbins, U. S. Geologic Survey, discuss the subject of minerals. He stated that a nation's strength is measured by her supply of minerals, chiefly coal, oil, gas, iron, copper, and the alloying elements. The availability and location of all major deposits were shown by maps and tables. It was clearly indicated that the United States enjoys a very favorable position in the field of minerals and mineral deposits.

Minerals Also Subject at Columbus Meeting

A discussion of essential critical and strategic mineral resources of different countries, together with a comparison of rates of production and consumption, was presented before the members of the Columbus Section on Dec. 15 by John D. Sullivan, chief chemist, Battelle Memorial Institute.

Central Indiana Section Holds Holiday Party

More than 60 members of the Central Indiana Section met at the Athenaeum, Indianapolis, Ind., on Dec. 15 for a preholiday social meeting which featured a series of short, interesting talks. All present enjoyed the informal character of the affair.

D. J. Mack Talks on Metals at East Tennessee

David J. Mack, professor at the University of Tennessee, was the speaker at the Dec. 15 meeting of the East Tennessee Section. He discussed the various metals which are of interest to mechanical engineers.

150 Engineers Attend Fall Meeting of Florida Section

More than 150 engineers were the guests of the Florida Section at its fall meeting on Dec. 28, 1939. Program features included a technical session in the morning, special entertainment for the women, luncheon, and a social gathering in the afternoon.

Los Angeles: "It" Causes Failure, Looks Bad, and Does Damage

The above was propounded in the announcement of the Dec. 14 meeting of the Los Angeles Section. When 140 members and guests came to the meeting, they found that the "it" was corrosion. The mechanism of corrosion and some of the theories of its formation were discussed by Guy Corfield. Protection against corrosion was the subject of the second paper, presented by Dr. Gordon N. Scott. Known as cathodic protection, this method depends upon the fact that whenever an electric current discharges from a metal into a surrounding solution there is a loss of metal. Reverse this action and make the current flow from the solution to the metal and the corrosion will be prevented. Thus, pipe, condenser tubes, steel framework, or any other metal structure can be protected from the ever-present enemy of steel—corrosion.

Pressure Maintenance Topic at Mid-Continent Section

E. O. Bennett, Continental Oil Company, was the guest speaker at the Dec. 4 meeting of the Mid-Continent Section. His subject was "Pressure Maintenance and Condensate Recovery." More than 120 members and guests enjoyed the talk as was evidenced by the many questions asked.

New Orleans Has Meeting on Gas and Air Conditioning

Application of gas to air conditioning was the subject of the paper presented by G. E. May, utilization engineer, New Orleans Public Service Co., before the New Orleans Section on Dec. 15. The various methods which have been developed were described and practical applications discussed.

North Texas Learns About Making Bars From Rail Steel

W. A. E. Woods, engineer with Texas Steel Co., the only steel company in Texas operating

THE MANY INSPECTION TRIPS, PLANNED BY ENERGETIC COMMITTEE MEMBERS, ARE ALWAYS INTERESTING
(Shown here are two groups which visited the Westinghouse plant during will also offer an extensive list of

a steel rolling mill, told 32 members and guests of the North Texas Section, Dec. 11, how his plant is rerolling rail steel into reinforcing bars and other shapes.

Industrial Preparedness Discussed at Rochester

The Dec. 14 meeting of the Rochester Section, attended by more than 130, was devoted to a paper on "Industrial Preparedness," presented by Major Roy L. Bowlin, Ordnance Department, U. S. Army. The subject, according to a report received from the secretary, was "Confidential—cannot be quoted in press." So, that's that.

Superfinish Program Before St. Louis Section on Dec. 15

Superfinish was the topic of the paper presented by John Hutcheson, production-research department, Chrysler Corporation, on Dec. 15 before the St. Louis Section. He discussed in general the reasons for the development, methods, equipment, and possible application. The talk was illustrated with slides as well as a display of actual superfinished parts.

A.S.M.E. Calendar

of Coming Meetings

May 1–3, 1940
Spring Meeting
Worcester, Mass.

June 17–21, 1940
Semi-Annual Meeting
Milwaukee, Wis.

September 3–6, 1940
Fall Meeting
Spokane, Wash.

(*For coming meetings of other organizations see page 22 of the advertising section of this issue*)

U. S. Civil Service Plan Discussed at Washington

Arthur S. Flemming, Commissioner, U. S. Civil Service Commission, spoke before 100 members and guests of the Washington, D. C., Section at the meeting held on December 14.

"Recent Trends in Recruiting for Professional and Scientific Positions in Federal Service," the paper discussed the purpose and authority of the U. S. Civil Service Commission. Three definite trends in recruiting personnel were defined as adoption of a recruitment policy similar to that of industry, use of oral examinations, and development of committee type of general examinations.

Union Pacific Locomotive Described at Worcester

The Union Pacific locomotive, which was described in detail in the October and November, 1939, issues of MECHANICAL ENGINEERING, was discussed by Clarence Bailey, transportation engineer, General Electric Co., at the Dec. 11 meeting of the Worcester Section.

Junior Group Activities

75 Members and 50 Guests at Detroit Junior Meeting

MEMBERS of the Detroit Section, numbering 75, and 50 guests accepted the invitation of the Detroit Junior Group to attend a meeting on Dec. 12, 1939, at the engineering laboratory of the University of Detroit, at which a demonstration and talks on the development, design, and application of hydraulic couplings were presented. The talks were given by the following Juniors: G. J. Scranton, Ford Motor Company; R. M. Nelden, American Blower Corporation; and F. A. Jennings, Chrysler Corporation.

It was shown through actual tests that the hydraulic coupling is not capable of torque conversion and should not be confused with torque converters. Hydraulic couplings have only two elements, the impeller and the runner. The torque at the output shaft is equal to the torque at the input shaft at all conditions of speed, filling, and slip. Since there is no reaction or intermediate guide vane, the coupling is incapable of torque conversion regardless of the blade design. The types of couplings available are the traction, scoop-controlled, variable-speed, and marine.

New Orleans Junior Group Chairman Presents Paper

AT a meeting of the New Orleans Junior Group on Nov. 30, 1939, J. K. Mayer, assistant professor of experimental engineering at Tulane University, presented a paper on "Hydraulic Losses at Pipe Entrances," covering the results of research carried on for several years at the Tulane University hydraulic laboratory.

Mr. Mayer is chairman of the Junior Group and his selection to deliver this paper was in line with the policy of the Group to have its members as speakers whenever possible. The paper was very well received and considerable discussion followed.

Ontario Junior Group Holds Meeting on Canadian Aviation

THE Controller of Civil Aviation in Canada, John Armitstead Wilson, was the guest speaker of the Ontario Junior Group at its Dec. 14 meeting. Mr. Wilson traced the development of aviation in Canada from the early days. He showed how the airplane has been

FEATURES OF LOCAL AND NATIONAL MEETINGS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
the 60th Annual Meeting in Philadelphia. The Spring Meeting in Worcester, Mass., industrial plant inspection trips.)

instrumental in opening up almost otherwise inaccessible areas of the north country and the growth and operation of the Trans-Canada Airways was outlined.

Philadelphia Junior Discusses Patents and Patent System

DURING the 1939 Annual Meeting which was held in Philadelphia, Dec. 4–8, 1939, a Junior and Student session was held on Wednesday morning, Dec. 6. Among the speakers was Zachary T. Wobensmith, Junior A.S.M.E., who, as the representative of the Philadelphia Junior Group, discussed patents and the patent system. After a review of the history of patents, Mr. Wobensmith listed the present classes of subject matter accorded protection, as follows:

1 An art, which comprises an act or a series of acts performed by an agency upon an object usually either physical or chemical, and bringing about a change in state, character, or condition.

2 A machine, in which moving parts when set in motion cooperate to produce predetermined physical effects.

3 A manufacture, which embraces articles of manufacture or implements made by human agency from raw or prepared materials.

4 A composition of matter, which is an instrument formed by the intermixture of two or more ingredients, and possessing properties which belong to one of these ingredients in their separate state.

5 An ornamental design, which relates to the surface ornamentation of an article of manufacture.

6 An asexually reproduced plant other than tuber-propagated.

Metropolitan Juniors Start Marine-Power Seminars

THE Metropolitan Junior Group members participated in the marine-power seminar held on Jan. 9 in the Engineering Societies Building. Much discussion was evoked by the paper on "General Thoughts on the Determination of Heat-Transfer Coefficients," given by A. Hutton, chief engineer, Davis Engineering Corp. There were 55 juniors and members present at this second session of the recently organized marine-power seminar group.

The first session in December featured a talk by D. C. McMillan which helped to organize the group. The enthusiastic reception given to this new activity is mainly due to the great increase of interest in naval and civil marine design and construction.

E.C.P.D. Postgraduate Aid to Juniors in Bibliographies

JUNIORS and members of the A.S.M.E., who are interested in continuing their study in engineering and allied fields, may obtain untold assistance from a set of five selected bibliographies prepared by the Committee on Professional Training of the Engineers' Council for Professional Development. The subjects covered in the various sections are as follows: Section I—Mathematics, Mechanics, and Physics; Section II—Aeronautical Engineering and Civil Engineering; Section III—Chemistry, Chemical Engineering, and Industrial Engineering; Section IV—Electrical Engineering and Mechanical Engineering; and Section V—Metallurgy, Mineralogy, Geology, and Mining Engineering.

In mechanical engineering, the topics covered are air conditioning, drafting, design, fuels, furnaces, heat transfer, heat power, internal-combustion engines, machine shop, refrigeration, steam power, textiles, and thermodynamics. Each reference to a book also contains annotations to indicate the nature and depth of subject matter. A limited number of these bibliographies are still available and may be obtained from the E.C.P.D., 29 West 39th St., New York City, at 10 cents a section.

With the Student Branches

Opportunity of Winning $200 in Cash Available to A.S.M.E. Student Members

Winning Papers of 1939 by James R. Bright and David T. James Published in This Issue

OPPORTUNITY is knocking at the door of every student member of the A.S.M.E. through the 1940 contests for the Charles T. Main Award of $150 and the two student awards of $25 each. If you are a senior student, it may even help you get that big job in that certain company. All in all, taking part in the contest, whether you win or not, will give you much valuable experience in the preparation of a technical paper. Some of the biggest men in the engineering world today tried out for the awards in their student days. However, there's one catch—you will have to work. Perhaps a little extra work on your thesis will do the trick.

Charles T. Main Award

The 1940 Charles T. Main Award will be given for the best paper received by the Committee on Relations With Colleges on or before June 30, 1940, on the subject of "What Has Been the Effect of Technological Advance on

Employment?" A complete bibliography and contest rules may be obtained from the honorary chairman of each A.S.M.E. Student Branch. An abstract of the paper by James R. Bright, of Lehigh University, which won for him the 1939 Award, will be found on page 147 of this issue.

A.S.M.E. Student Awards

Then, there are two awards, $25 each, for the best papers received by the Committee on or before June 30, 1940, on any engineering subject or investigation, prepared by A.S.M.E. student members under the direction of the department of mechanical engineering at the school. One award is for a graduate student and the second one for an undergraduate student. The honorary chairman of the Student Branch will be glad to furnish all details. As a matter of fact, it is permissible to submit a term thesis. The winning undergraduate paper of 1939, written by David T. James, of Michigan State College, on the topic of "Bells—Concerning Their Tones," was so good that it has been published in full in this issue of MECHANICAL ENGINEERING on page 117. Furthermore, both of the 1939 winners were offered and accepted engineering positions with two of the largest companies in the world, Mr. Bright with the General Electric Co. and Mr. James with E. I. du Pont de Nemours.

Branch Meetings

Akron Honors Former Member

ON NOV. 28, the AKRON BRANCH honored a former student member at the school by inviting him to give a talk. The speaker was Alex Walker, '36 graduate and now secretary of the A.S.M.E. Akron-Canton Section.

ARMOUR BRANCH reports 100 per cent senior membership for the current school year. Already, student members are presenting papers in preparation for the 1940 Student Group Conference. At the Dec. 1 meeting, attended by 60 members, R. Smessaert spoke on "Industrial Inspection," and M. R. Balis discussed "Termite Control." On Dec. 12, an inspection trip was made to the West Pullman, Ill., plant of the International Harvester Co.

ARIZONA BRANCH had a very interesting meeting on Nov. 29 when John Chaffee, Hobart Brothers Co., gave an illustrated lecture on welding machines and arc welders.

BUCKNELL BRANCH showed two movies at its Dec. 7 meeting—one on "The Story of Nickel," and a second about "The International Harvester Diesel." This first evening meeting proved so successful that a second was held on Dec. 19 in the engineering lab and featured a treasure hunt, ping-pong, and refreshments.

Carnegie Entertains Pittsburgh

CARNEGIE TECH BRANCH entertained 30 student members of PITTSBURGH BRANCH at a meeting on Dec. 14 in the Carnegie Student Union. The address of the evening was given by H. F. Robey, Aluminum Co. of America, who described with the aid of motion pictures a novel method of constructing a cofferdam in a swiftly flowing stream in Canada. Following a period of discussion, refreshments in the form of doughnuts and coffee were enjoyed by the visitors as well as the 30 student members of the host Branch.

CATHOLIC UNIVERSITY BRANCH members heard an interesting talk on the evening of Nov. 13 about aircraft engines as given by John Boston, aeronautics department, U. S. Bureau of Standards.

COLORADO MINES BRANCH met on Dec. 6 to learn about perforating casing and well surveying methods from the guest speaker, John Davis, Lane-Wells Gun Perforating Co.

COOPER UNION BRANCH (evening) presented L. P. Flood, buyer of automotive equipment for the City of New York, as the speaker for the Dec. 11 meeting. Mr. Flood presented an illustrated talk on the engineering evaluations and problems encountered in the purchase of automotive equipment.

George Washington Erects Tree

In accordance with a traditional custom, the Christmas tree on the campus of GEORGE WASHINGTON UNIVERSITY was again obtained by the student members of the A.S.C.E. chapter, erected by the A.S.M.E. student members, and decorated by the A.I.E.E. membership. Following this, the girls' glee club sang Christmas songs under its branches.

IDAHO BRANCH tried out a new stunt at its Dec. 7 meeting which featured a film on boilers. To insure prompt attendance, cider and cookies were served at the beginning of the meeting instead of at the end. In other words, the boys had a "cocktail hour" preceding the meeting.

IOWA STATE UNIVERSITY BRANCH is encouraging the presentation of papers by student members. Speakers at the Dec. 13 and Jan. 3 meetings were Gordon Colony, Robert Sykes, M. Olson, J. Linsley, and G. Hirt.

KANSAS BRANCH held a joint meeting with the A.S.C.E. chapter on Dec. 7. The speaker of the evening was Walter Bohnstengel, chief test engineer, Atchison, Topeka & Sante Fe R.R. He talked on "Developments in Transportation."

Kentucky Starts Assembly

Tom C. Jackson, the hard-working secretary of KENTUCKY BRANCH, reports that under the sponsorship of the Branch a mechanical-engineering assembly has been organized for the discussion of engineering and student problems.

MARQUETTE BRANCH met on Dec. 5 to listen to a talk on the manufacture and installation of Diesel engines given by J. H. Ford, Nord-

MID-CONTINENT SECTION OF THE A.S.M.E. STUDENT CONFERENCE, DEC. 12, 1939, AT TULSA, OKLA.

December Student Conference Held by Mid-Continent Section

UNDER the sponsorship of the Mid-Continent Section of the A.S.M.E. and the Engineers Club of Tulsa, a student conference was held at the University of Tulsa on Dec. 12. Following an inspection trip in the afternoon, conducted by William J. Overton, secretary of the A.S.M.E. Petroleum Division, to the Sheffield Steel Corp., the Commander Mills, and the Hinderliter Tool Co., the 65 student members and 12 members of the A.S.M.E. arrived at the University for the evening meeting. Each speaker, one from each of the three schools, presented 15-minute papers. John T. Stewart, OKLAHOMA A.&M. BRANCH, spoke on "Combating Paraffin Deposits in Producing Wells;" Bernard Jones, OKLAHOMA BRANCH, discussed "Volume Meter Research at the University of Oklahoma;" and George Alden, TULSA BRANCH (A.I.M.E.), described "Use of Radioactive Minerals in Oil-Well Cement."

A discussion period followed. Then, Charles H. Bloom, chairman of the membership committee, E.C.T., presented each speaker with a student membership in the Club. Following this, Hollis Porter, fellow A.S.M.E., representing the Mid-Continent Section, gave each speaker a five-dollar bill. An SKF slide rule was won as a door prize by Hubert Brooke, OKLAHOMA A.&M. BRANCH. Beside souvenirs of abrasives, ash trays, and pencils from various manufacturers, the boys were given refreshments consisting of orange juice, coffee, and doughnuts.

berg Mfg. Co. After the meeting, apples and popcorn were served.

MICHIGAN STATE BRANCH had 150 at its Nov. 29 meeting to hear a talk on aerial photography. The speaker was Talbert G. Abrams, one of the foremost aerial photographers in the United States. It was a very successful meeting, reports Roger McIntyre.

MISSISSIPPI STATE BRANCH members gathered on Dec. 7 to hear Dr. V. A. Coulter, of the University of Mississippi, talk on chemical warfare. More than 50 were present.

MISSOURI MINES BRANCH had an aeronautical meeting on Dec. 8. The speaker was W. W. Bishop, Jr., superintendent of tests, Wright Aeronautical Corporation.

Newark Has 110 Members

At the Dec. 7 meeting of NEWARK BRANCH, it was announced that the membership had reached 110. The program consisted of a paper on "Industrial Air Conditioning," by Dwight Tenney, Tenney Engineering Corp.

NEW HAMPSHIRE BRANCH members made an inspection trip on Dec. 11 to the Somerville plant of the Ford Motor Co. and the Mystic Iron Works in Boston.

MADELINE STEARNS

(Student member of New Hampshire Branch. She builds model airplanes and has made several flights in a primary glider.)

NORTHEASTERN BRANCH held a joint meeting with the A.S.M.E. Student Branches at M.I.T. and TUFTS on Dec. 14 to hear a talk on blind flying, given by John Horcum, Sperry Gyroscope Co.

PENN STATE BRANCH held its third meeting of the year on Dec. 11 in conjunction with the Center County Engineering Society of Pennsylvania. W. G. Theisinger, Lukens Steel Co., gave a lecture on "Welding and Heat Stresses in Welding."

PURDUE BRANCH had W. H. Pugsley as the speaker on Dec. 6. He is director of engineering of the Hayes Corp. His subject was "Instrumentation and Automatic Control of a Modern Steam-Generating Plant."

R.P.I. Learns About Business

Addressing a joint meeting of the R.P.I. BRANCH of the A.S.M.E. and the A.S.C.E. chapter on Dec. 12, Edgar G. Hill, president of Ford, Bacon & Davis, discussed the non-technical or business training a prospective engineer should acquire in college if he wishes to be fully equipped for a position in the engineering world. To do this, he must develop himself culturally by means of liberal arts subjects and extracurricular activities.

ROSE TECH BRANCH met on Dec. 7 and had student members Eder, Fleming, Thodal, and Huggins discuss various phases of "The Place of the Diesel Engine in Our National Defense."

RUTGERS BRANCH had more than 30 members attend the Annual Meeting of the A.S.M.E. held in Philadelphia, Dec. 4-8, 1939.

SOUTHERN CALIFORNIA BRANCH is getting ready for the 1940 Student Group Conference by training its speakers in the presentation of papers. Roger Boles and Jay Galloway spoke on Jan. 10.

Tennessee Welcomes Woolrich

Formerly a professor at the University and now dean of engineering at the University of Texas, Dean W. R. Woolrich, member of A.S.M.E. Council, was the guest speaker before the TENNESSEE BRANCH on Dec. 6.

TEXAS BRANCH held a joint meeting with the A.I.E.E. chapter on Dec. 11. Dr. Phillips Thomas, research engineer with Westinghouse, told of some of the newest applications of electricity in the fields of medicine, illumination, and magic.

TEXAS A.&M. BRANCH showed a talking motion picture about the alloying of steel at its meeting of Dec. 5.

TEXAS TECH BRANCH is proud of the fact that with the school only 15 years old, there is a student body numbering more than 3800 with 900 of these students taking engineering.

TUFTS BRANCH had as guest speaker at its Nov. 16 meeting, A. G. Lyeth, Babcock & Wilcox Co., who gave an illustrated talk on "Modern Trends in Boiler Design."

Vermont Opens New Lab

Under the auspices of the VERMONT BRANCH of the A.S.M.E., the mechanical-engineering department's new laboratory was opened on Dec. 8 with appropriate ceremonies arranged by the Branch members. In a quiz contest between a team of professors and a team of student members, the students won because of the familiarity of one student with Canadian ale.

VIRGINIA BRANCH presented on Dec. 7 in the auditorium of Thornton Hall several reels of motion pictures on the subject of forging.

WASHINGTON BRANCH members numbering 69 attended the annual Christmas party of the Branch in Seattle. After talks were presented by Edgell Robertson and Stan Laing, motion pictures of school sports were shown. This was followed with the distribution of free favors, smokes, candy, gum, and valuable prizes.

YALE BRANCH had W. W. Boring, personnel department of General Electric Co., as the speaker on Dec. 12.

A.S.M.E. STUDENT MEMBERS OF THE MISSOURI SCHOOL OF MINES BRANCH

(Shown in the photograph is Dr. Aaron J. Miles, honorary chairman, who was the first president of the Branch when it was organized in 1930.)

Employment Opportunities for June Engineering Graduates

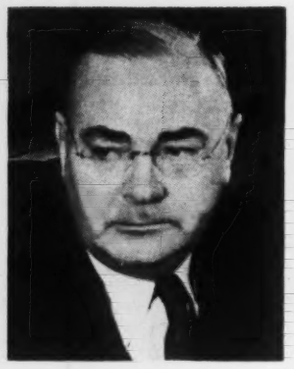
A list of positions available in private industry and government service is given on page 184. It should be noted that the closing date for the Junior Professional Assistant government position is Feb. 5. Applications for jobs in private industry may be obtained from Engineering Societies Employment Service.

Library Receives Teknik Lûgat Prepared by Amiri L. A. Scipio

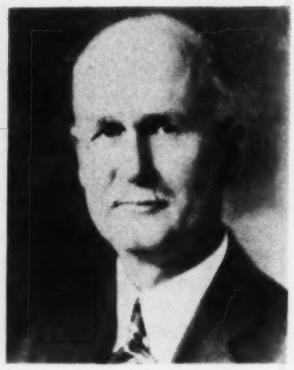
ONE of the latest accessions of the Engineering Societies Library, New York, N. Y., is a Teknik Lûgat—Ingilizceden Türkceye (Technical Dictionary—English to Turkish), donated by its compiler, L. A. Scipio, member A.S.M.E. and amiri (dean) of the mühendis kismi (department of engineering) at Robert College, Istanbul, Turkey. Dean Scipio, who has many acquaintances among A.S.M.E. members, in his letter accompanying the dictionary says:

Living in this part of the world, it is not always easy to get information which I desire and the Engineering Societies Library has been so helpful to me for many years that I want to do something in return. It has taken me $2^1/_2$ years to prepare this little dictionary and, since our engineering body in New York and America is of such metropolitan character, it is just possible that someone may find use for it.

As one glances through the 224-page book, he notes that the vocabulary is well chosen, the typography pleasing, and the format convenient. In the foreword, the author states that Turkish technical language is in process of development. For the linguists of the A.S.M.E., a few samples from the dictionary follow: Mechanical engineer—mühendis mihanîkî; boiler—civa kazani; Diesel engine—Dizel makinesi; machine shop—makine dairen; process—ameliye; steam engine—kuru istim makinesi; draftsman—ressam; and lubricating oil—yağlama yağı.



J. M. CARMODY



A. J. HAMMOND

O. S. BEYER

American Engineering Council Holds Twentieth Annual Assembly

Engineers' Relation to Public Affairs and Council Reorganization Discussed at Washington, January 11 and 12

ONCE again the American Engineering Council, at its twentieth annual assembly, held at the Mayflower Hotel, Washington, D. C., January 11 and 12, 1940, provided the usual "lift" to those who took part in its deliberations. Once again it served to strengthen the purposes for which A.E.C. exists and the determination of those most closely associated with its program to continue its activities and increase its prestige and usefulness. "The Council must and will go on," was the statement frequently repeated throughout the two-day sessions and at the popular All-Engineers' Dinner with which the 1940 Assembly officially closed.

Reorganization Plans Discussed

Perennial questions of objectives, program, organization, financial support, and the interest and enthusiasm in A.E.C. activities displayed by the engineer in the field whose representation on the Council comes through his membership in one of its constituent society bodies were rendered more acute than ever this year by reason of the resignation, effective July 1, 1940, of F. M. Feiker, for the last five years executive secretary. Mr. Feiker, after long and careful deliberation, has accepted the deanship of engineering at George Washington University. The Council therefore faces the immediate problem of choosing Mr. Feiker's successor. This task will be importantly affected by whatever decision is reached on the reorganization of the Council now under consideration by a committee of twelve composed of three representatives from each of the three Founder Societies that are members of the Council, A.S.C.E., A.S.M.E., and A.I.E.E., and three representatives of the Council itself.

The committee on reorganization, it was reported, met on November 27, 1939, discussed its problem, and reviewed several suggested plans of organization that the Council might adopt. Aside from unanimous agreement that the Council was essential to the engineering profession and must go on, no conclusions that could be reported to the Assembly were formulated. Discussion of the plan and scope of the Council, however, was active on the floor of the Assembly at Washington and undoubtedly served to acquaint members of the committee with the views of delegates to the Assembly.

Alonzo J. Hammond Elected President

Officers of the American Engineering Council elected at the 1940 Assembly are as follows: President (two-year term), Alonzo J. Hammond, Chicago, Ill., past-president A.S.C.E.; vice-presidents (two-year term), W. L. Batt, Philadelphia, past-president A.S.M.E., and D. H. Sawyer, president A.S.C.E., 1939; treasurer (one-year term), Leonard J. Fletcher, Peoria, Ill., past-president American Society of Agricultural Engineers. F. M. Feiker was reelected executive secretary to serve until his successor is appointed. F. M. Farmer of New York, president A.I.E.E., was elected chairman of the Finance Committee, and Warner Seely of Cleveland, Ohio, member A.S.M.E., was reelected chairman of the Committee on Membership and Reorganization.

Following a procedure that has met with marked success during the last years, members of the Assembly enjoyed the privilege of listening to frank discussion of matters affecting the interests of engineers in several addresses by representatives of government agencies located in Washington.

Carmody on Federal Works Agency

The first of these addresses was delivered at the Public Works luncheon, on Thursday noon, which preceded the first session of the Assembly and at which Alonzo J. Hammond, chairman A.E.C. Committee on Public Works, presided. The Hon. John M. Carmody, administrator, Federal Works Agency, was the guest of honor. Mr. Carmody reviewed briefly how the Federal Works Agency came into being as a result of the reorganization bill which grouped a number of Federal bureaus, or formerly independent agencies, under one of several departments of the government, under the new FWA. He spoke about the work and problems of several of these such as PWA, Bureau of Public Roads, the United States Housing Authority, the WPA. He said that he was aware of the fact that engineering societies had advocated a Federal Department of Public Works, headed by a cabinet officer, instead of the Federal Works Agency as it was actually set up. Suggestions would receive the attention of the Agency, and he hoped the A.E.C. would make them. He knew of no reason why the Federal Works Agency should not be made an acceptable organization, and hoped that he would be able to demonstrate his concern for the efficient operation of public works.

Engineer Arbitrators Urged by Beyer

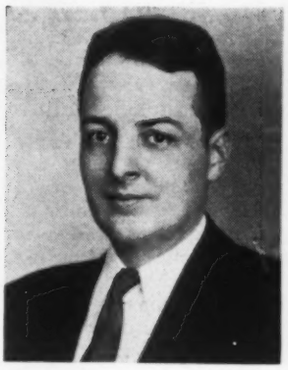
Second of the guest speakers to address the Assembly was Otto S. Beyer, chairman National Mediation Board, whose subject was "Engineers as Arbitrators." Dr. Beyer expressed the opinion that the engineer's knowledge, experience, and methods of thought qualified him as a mediator and arbitrator in disputes arising out of the National Labor Relations Act and other labor and wage controversies. The difficulty of finding men to undertake the tasks of mediators and arbitrators was great, he said, and engineering societies were urged to make available to the appropriate government agencies, such as the National Mediation Board, panels of engineers willing and competent to perform such duties. Numerous examples of instances in which engineers had served in labor disputes were offered.

William McClellan, president A.E.C., who presided at this and all other sessions of the Assembly, emphasized the importance of Dr. Beyer's address and said that the engineer must demonstrate by the life he led and the position he held in the community that he was civic-minded and could be trusted to act wisely in such duties as those which Dr. Beyer had called upon him to perform.

Attests Importance of Patent System

At the luncheon on Friday, at which A. A. Potter, past-president A.S.M.E. and chairman, A.E.C. Committee on Patents, presided, the Hon. Conway P. Coe, United States Commissioner of Patents spoke imformally about the history and development of the Patent

W. T. FOSTER



A. S. FLEMMING

C. P. COE

Office. He said that the patent system had been criticized by some as being responsible for economic troubles. In his own opinion the United States patent system had contributed as significantly as any other factor to the economic and social welfare of the Nation and that it gave promise of further and greater benefits. It made us able to resist assaults on democracy as it provided the material might necessary to maintain moral right. He was not dismayed by the concern shown over the system, which, he was convinced, did not need to seek shelter from investigation. If investigations, which were providing further evidence of the system's value, uncovered defects, correction of these defects would thereby be hastened.

Professional Engineering Fees Discussed

Another guest speaker, A. C. Shire, technical director, United States Housing Authority, addressed the Friday afternoon session of the Assembly following presentation of a report by the Committee on Engineers' Economic Status, J. S. Dodds, chairman, devoted to the important subject of fees for professional services. Mr. Shire said that the architects, but not the engineers, had been quick to enter the field of housing. He described studies that had been made by the USHA of professional fees and revisions and changes made in them and explained the relationship of the Authority to local authorities and of engineering consultants to the architects. Copies of a revised schedule of fees recommended to local housing authorities were distributed and discussed.

Mr. Shire took engineers to task for not having available accurate pay-roll and cost records upon which fair fees could be based and urged them to find out, preferably by means of some uniform accounting procedure, the engineering costs on projects now in progress. M. X. Wilberding, member A.S.M.E., who had worked with Mr. Shire on the schedule of fees, expressed the appreciation of engineers for the interest taken by USHA. He said that engineers had no standard form of contract, but needed one.

Flemming on Plight of Civil Service Commission

The handicap of inadequate staff and increased demand, aggravated at present by the needs of the national defense program, was ably dramatized by Commissioner Arthur S. Flemming, of the United States Civil Service Commission, who spoke at the Friday afternoon session of the Assembly. He quoted a host of statistics to prove the rapid growth of the number of employees in the federal government whose appointments came under the Civil Service rules and the increasing extent of the delay that had been occasioned because of this growth and the insufficiency of the present number of examiners. What the Commission was attempting to do not only to cut down these accumulating arrearages in the load placed upon the examiners but also in improving the technique of examination demonstrated, in his opinion, the desire of the Commission to engage in constructive thinking on the problems of its task.

Assistance to Latin American Students

On Friday morning Prof. F. N. Menefee, University of Michigan, urged the Council to take an interest in Pan-American engineering educational relationships in connection with the program of the State Department in improving cultural relations by means of the exchange professors and students between the United States and Latin American Nations. Professor Menefee particularly urged assistance by means of providing summer work in industries in this country for engineering students studying in schools in this country. Replies to a questionnaire addressed to eight engineering and industrial plants indicated in general the willingness of these institutions to view the proposal sympathetically and cooperate. It was also brought out that there were many problems to be studied and immigration and State Department regulations to be considered. Guest speakers from the State Department and the Pan American Union took part in the discussion and seconded Professor Menefee's appeal.

It was pointed out by the speakers that the State Department was in a position to inform engineering and industrial concerns of the proposed visits to this country of Latin American engineers, and C. E. Davies, secretary A.S.M.E., assured the Department of the welcome and assistance visiting engineers would experience at the Engineering Societies headquarters in New York.

Many A.E.C. Committees Report

In addition to the addresses by guest speakers which have been inadequately summarized in the foregoing, more than a dozen committees of the Council presented annual reports to the Assembly. Important items covered in these reports are referred to briefly in the annual report of the executive secretary, F. M. Feiker, which appears in the January, 1940, issue of the *A.E.C. Bulletin*.

All-Engineers' Dinner Fills Ballroom

Social events featured as part of the Twentieth Annual Assembly of the American Engineering Council were the tea held at the home of Mr. and Mrs. F. M. Feiker, on Thursday afternoon, and the All-Engineers' Dinner, preceded by a reception, that filled the ballroom of the Mayflower Hotel Friday night.

William McClellan, president A.E.C., presided at the dinner and acted as toastmaster. He introduced the distinguished guests at the speakers' table, among whom were two past-presidents of the A.S.M.E., R. E. Flanders and A. A. Potter, and James W. Parker, vice-president A.S.M.E., who represented Warren H. McBryde, president A.S.M.E., absent because of illness.

Following a brief talk in which he reminded engineers that it was their responsibility to engage in civic affairs without waiting to be sought out and invited to participate, Mr. McClellan asked Mr. Flanders to introduce Dr. William T. Foster, director of the Pollak Foundation, Newton, Mass., who made the principal address of the evening. Dr. Foster's address was called "Waiting for the Unborn Social Engineer." He expressed the opinion that engineers were proper persons to assist in the solution of economic problems, poked a good deal of fun at orthodox economists, and said that since underconsumption is the chief cause of our economic difficulties, adequate consumer demand would provide the solution.

Following the address, F. M. Feiker and Alonzo J. Hammond, incoming president, A.E.C., spoke informally.

Secretaries Hold Conference

The tenth annual conference of engineering societies held a series of sessions simultaneously with those of the A.E.C. Assembly.

O. L. Angevine, secretary of the Rochester Engineering Society, acted as chairman of the Conference. A. R. Cullimore, C. E. Davies, Maurice Holland, T. Keith Legaré, and Alfred H. Meyer were among the speakers who discussed civic affairs, joint engineering agencies, research, registration, and employment service.

Instruments and Apparatus Part 3, Chapter 3, Thermocouple Thermometers

Preliminary Draft of Instruments and Apparatus Section on Thermocouple Thermometers Completed

THE preliminary draft of this material is now completed and the A.S.M.E. Power Test Codes Committee on Instruments and Apparatus will welcome criticism or comment on it by members of the Society and others interested. Copies may be obtained by addressing the Power Test Codes Committee, A.S.M.E. headquarters.

The Committee in charge of this part of the Power Test Codes activity consists of W. A. Carter, chairman, C. M. Allen, W. C. Andrae, E. G. Bailey, H. S. Bean, L. J. Briggs, J. D. Davis, K. J. DeJuhasz, R. E. Dillon, F. M. Farmer, J. B. Grumbein, W. W. Johnson, W. H. Kenerson, E. S. Lee, E. L. Lindseth, O. Monnett, S. A. Moss, R. J. S. Pigott, E. B. Ricketts, W. A. Sloan, R. B. Smith, and I. M. Stein.

This chapter includes sections on noble- and base-metal thermocouples, protecting tubes, reference and measuring junctions, selector switches, multiple thermocouples, high-velocity thermocouples, precautions for measurements in flowing fluids, calibration, and tolerance.

Temperature measurement by thermocouples is accomplished by the measurement of the emf generated in the circuit when the measuring and reference junctions are at different temperatures. This emf is, in general, a function not only of the difference in temperature of the junctions, but of the actual temperature of the reference junction because of a lack of linearity of the emf-temperature curve for the given materials. For the thermocouples in ordinary use, this departure from linearity is so small in the range of temperature to which the reference junctions are subjected that, in comparing the constancy and reproducibility of thermocouples, it is sufficiently accurate to express variations as a percentage of the temperature difference between their ends rather than the more exact statement in terms of emf.

Because of the demand for material on the high-velocity type of thermocouple, a rather complete and detailed treatment of both the ordinary high-velocity thermocouple used for rigorous service and the compensated high-velocity thermocouple used where the utmost accuracy is desired has been included.

A.S.M.E. Semi-Annual Meeting

Milwaukee, Wis., June 17–21

Milwaukee, the birthplace of the Local Sections movement in The American Society of Mechanical Engineers, will be the host for the 1940 Semi-Annual Meeting of the Society, June 17–21. Meeting headquarters will be in the Hotel Pfister. Events scheduled include 21 technical sessions, an S.P.E.E. luncheon, plant visits to a dozen or more industrial plants, business meeting, dinner, and a smoker at one of the city's famous breweries. V. E. NORDBERG, chairman of the MILWAUKEE SECTION, asks every member of the A.S.M.E. to jot down the dates of the Meeting on his calendar now so that in making vacation plans later on, the member will include a visit to Milwaukee at the time of the Semi-Annual Meeting.

Metropolitan Section of Woman's Auxiliary

ON DECEMBER 14, the National Board of the Woman's Auxiliary to the A.S.M.E. met at the Engineering Woman's Club in New York City for a regular meeting and to take part in the inauguration of the officers of the recently formed Metropolitan Section of the Auxiliary. After the luncheon which followed the morning session, Miss Capdeville of the Stone Najjar Co. showed an attractive collection of handmade jewelry and explained the differences in workmanship from the different countries. Miss Burtie Haar, chairman of the Auxiliary's Publicity Committee, in her report of the meeting, says that in this era of change, even the birthstones of various months are being changed to suit modern ideas. The remainder of the afternoon meeting was devoted to a report of the Annual Meeting of the Auxiliary, held in Philadelphia, Dec. 5, 1939.

On Thursday, Jan. 11, 1940, the National Board and Metropolitan Section Board met in the morning at the Engineering Societies Building. The guest speaker at the afternoon session was Mrs. E. R. Mosher, president of the faculty wives of the College of the City of New York, who talked on the "House Plan of City College Students." She described plans for improving the contacts and social life of the students.

George J. Mead Receives Aeronautical Award

THE Sylvanus Albert Reed Award for 1939, conferred annually by the Institute of the Aeronautical Sciences in recognition of a notable contribution to aeronautical engineering, was presented January, 1940, to George J. Mead, member A.S.M.E. and vice-chairman of the National Advisory Committee for Aeronautics "for the design and development of high-output aircraft engines for military and commercial services." Mr. Mead studied at the Massachusetts Institute of Technology and in 1937 received the honorary degree of doctor of science from Trinity College. In 1937, he received the Taylor Medal awarded by the Royal Aeronautical Society of Great Britain. Since 1916 he has been continuously engaged in the engineering development of aircraft engines, having been chief engineer of the Wright Aeronautical Corporation, engineering founder of the Pratt & Whitney Aircraft Company, and subsequently vice-president and chief engineer of the United Aircraft Corporation. He has been largely responsible for the design of outstanding single- and double-row radial aircraft engines which have been manufactured in the United States and under license abroad. He has contributed many papers on aircraft power plants to technical journals.

Dean Ellery Is Elected President of Sigma Xi

AT its 40th annual convention in Columbus, Ohio, the latter part of December, 1939, the Society of Sigma Xi elected Dean Edward Ellery, former acting president of Union College and now chairman of the faculty, president for a two-year term. For 18 years, Dean Ellery has been national secretary of Sigma Xi, honorary scientific fraternity for the promotion of research in science. Prof. George A. Baitsell, Yale University, became the new national secretary after having served as president of the Society for the last two years.

Dr. William F. Durand, past-president A.S.M.E., and Prof. Harvey E. Jordan, of the University of Virginia, were elected to the executive committee. John C. Parker, Mem. A.S.M.E. and past-president A.I.E.E., and C. E. Davies, secretary A.S.M.E. were elected to the alumni committee.

Midwest Power Conference in Chicago, April 9–10

ANNOUNCEMENT has just been made that Armour Institute of Technology, in cooperation with seven middle-western colleges and universities and several local and national technical societies, is sponsoring the annual Midwest Power Conference to be held in Chicago, April 9–10, 1940, in the Palmer House, under the direction of Prof. Stanton E. Winston. Prof. Charles A. Nash is secretary of the 1940 Conference. More than 25 papers are tentatively scheduled to be presented by authorities from the educational and industrial fields.

Texas Tech Sponsors Welding Conference, Feb. 2–3

THE fourth biennial Welding Conference, covering electric and oxyacetylene welding, will be held at Texas Technological College, Lubbock, Texas, Feb. 2–3, 1940. All A.S.M.E. members interested in welding are invited to attend. There is no registration fee. Beside technical papers, including one by A. R. Keiler on "A.S.M.E. Code Requirements for Fusion Welding of Boilers and Unfired Pressure Vessels," there will be exhibits and demonstrations of equipment. Further information may be obtained from J. C. Hardgrave, department of mechanical engineering.

O. E. Buckley Chairman of Engineering Foundation

AT A MEETING of the Executive Committee of The Engineering Foundation, held November 28, 1939, Dr. O. E. Buckley, executive vice-president of the Bell Telephone Laboratories, New York, was chosen chairman of the Foundation to succeed Prof. George E. Beggs, who died on November 23, 1939. F. F. Colcord, vice-president and manager of metal sales of the U. S. Smelting, Refining and Mining Company, New York, was elected vice-chairman to succeed Dr. Buckley.

The executive committee is headed by Dr. Buckley as chairman; the other members are F. F. Colcord; K. H. Condit, executive assistant to the president, National Industrial Conference Board; A. L. Queneau, metallurgist of the U. S. Steel Corporation, New York;

O. E. BUCKLEY

and W. I. Slichter, professor of electrical engineering, Columbia University. Mr. Condit was elected to the chairmanship of the Foundation's Research Procedure Committee; Dr. Buckley, member ex officio; and E. M. T. Ryder, Way Engineer, Third Avenue Railway System, New York, was appointed to fill a vacancy on the Committee.

Dr. Buckley was born in Sloan, Iowa, August 8, 1887. He received the degree of bachelor of science from Grinnell College in 1909, and the degree of doctor of science from the same college in 1936; in 1914 he received the degree of doctor of philosophy from Cornell University.

He is best known in the engineering world for his pioneering work on high-speed submarine telegraph cables. Dr. Buckley had direct charge of the application of permalloy tape loading, and the development of terminal equipment which increased the carrying capacity fourfold. He entered the organization which later became Bell Telephone Laboratories in 1914. During the World War he had charge of the Signal Corps laboratory in Paris, with the rank of major. Returning to civil life, his work for the next eight years was on continuously loaded cables, and on the research problems therewith. Among activities under his supervision were studies in ferromagnetism, and development of new magnetic materials. Due to his ability as a leader, his staff was gradually augmented.

In 1927 he was made assistant director of research; and in 1933 he became director of research; in 1937, he was elected executive vice-president. As director of research he had charge of fundamental studies in a great variety of fields. Among the more important may be mentioned acoustics, electronics, photoelectricity, magnetism, microphonic effects, conduction of current in solids and gases, piezoelectric crystals, wire and radio transmission, chemistry, and telephone transmitters and receivers.

$200,000 in Cash Prizes to Be Given for Industrial Studies

A CONTEST in which $200,000 in cash awards will be given for the best 458 papers on studies bringing out the benefits of a social, economic, or commercial nature which attest progress in industrial development, has been announced by The James F. Lincoln Arc Welding Foundation. Studies must, however, report progress which can be attributed to application of the electric-arc process of welding within a $2^1/_2$-year period, Jan. 1, 1940, to June 1, 1942. Such progress may involve one of the following: (*a*) Redesign and manufacture or construction of an existing machine, structure, building, manufactured or fabricated product of ferrous or nonferrous metals. (*b*) New design and manufacture or construction of a machine, building, etc., as in (*a*). (*c*) Organization, development, and conduct of a welding service. (*d*) Development, planning, and performance of maintenance or repair work with arc welding.

Participation in the contest is open to every one who plays any part in actually bringing about progress in the executive, design, fabrication, manufacture, construction, or maintenance phase of industrial product or structure development. Authors of studies may be executives, engineers, designers, draftsmen, plant superintendents, production managers, or any other person engaged in the various phases previously mentioned. One author, or a group of authors, may submit a paper. Innumerable subjects are suitable for study. The 12 classifications and 46 divisions of participation cover every conceivable machine, building, structure, or product made of ferrous or nonferrous metal.

All inquiries concerning the contest should be addressed to A. F. Davis, secretary, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Gas-Engine Handbook Available From A.G.A.

A HANDBOOK on gas engines has been published by the Industrial Gas Section of the American Gas Association. The book covers not only the function, but also the application of these engines. However, the matter of operating and maintaining gas engines, once they are properly installed, has not been included. A.S.M.E. members may obtain a copy of the 58-page handbook for $1 a copy from the American Gas Association, 420 Lexington Ave., New York, N. Y.

American Engineering Council

Presents

The News From Washington and Elsewhere

Air Defense Expanded

WITH the formation of 52 new air squadrons, virtually doubling the number of its combat units, the U. S. Army will shortly put into effect a major reorganization involving the separation of offensive and defensive units in the northeastern areas.

At present, all mobile combat air units are concentrated into one organization, the General Headquarters Air Force, with both offensive and defensive responsibilities. Under the new plan the defense of the important northeastern industrial area, including a large proportion of the country's population and the seat of government at Washington, will be assigned to a separate group under the command of Colonel James E. Chaney, Air Corps, who will be elevated to the rank of brigadier general. Subject to his orders will be not only Air Corps units equipped with new interceptor pursuit-type planes, but also antiaircraft defense artillery and Signal Corps communication units to set up a warning service. Thus the General Headquarters Air Force will be relieved of responsibility for defense from air attack and will be able to devote its entire efforts to offensive operations.

Finch Forced to Resign as Mines Bureau Chief

American Engineering Council reports that long-continued friction between Secretary of the Interior Harold L. Ickes and personnel of the Bureau of Mines has resulted in a request for the resignation of its director, John W. Finch, which has been submitted to take effect January 31. The immediate cause of the disagreement was given as a failure of the Bureau to fully support a proposed bill that would give the Interior Department authority to order the inspection of coal mines as regards health and safety provision. This, it is charged, is desired by Secretary Ickes as a means of putting pressure on mine owners to comply with the Guffey Act. Its opponents state that it would require the employment of several hundred inspectors who would merely duplicate the work now done by state officials. It is known, however, that in the past there

have been other sources of disagreement, specifically a Bureau statement criticizing the reduction in the tariff on zinc in the Canadian trade agreement and its approval, without the knowledge of the Secretary, of the export of helium to Germany before the present war.

Negotiations Resumed on St. Lawrence Waterway

Final agreement on the details of a treaty between the United States and Canada for the construction of the long-advocated St. Lawrence waterway, which would admit ocean-going steamers to the Great Lakes and develop a large quantity of low-cost power, is being sought by negotiators representing the two countries. The United States has sent to Ottawa a three-man delegation for this purpose composed of Assistant Secretary of State, Adolph A. Berle, Chairman I eland Olds of the Federal Power Commission, and John Hickerson, assistant chief of the State Department's division of European affairs.

Before becoming effective the treaty must be ratified by both governments, and powerful opposition has been expressed to it in both countries. The Canadian attitude, it has been reported, is much more favorable now than formerly because of the increased need of Canadian industry for power to fulfill war requirements. In the United States opinion is divided along sectional lines, the waterway being favored by shippers of bulk products, such as wheat, in the Midwest, and opposed by eastern states which fear the resultant diversion of traffic from their seaports.

Power Costs Analyzed

Residential, commercial, and industrial bills for electric power in the 48 states as of January 1, 1939, are analyzed in a comprehensive 73-page report issued by the Federal Power Commission. Data for this study are taken from the Commission's rate series, already issued for each state. The report is designated as FPC R-17, and can be obtained from the Commission for 10 cents per copy. It is in five parts, the first comparing bills in the various classes by states and geographic regions; the second comparing bills according to sizes of communities; the third those submitted by private and by public utilities; the fourth, electricity costs in 1935, 1937, and 1939. The final section discusses the statistical methods used in averaging the data contained in the state series.

Power Capacity Growing

As of September 30, 1939, the installed capacity of all electric generating plants reporting to the Federal Power Commission aggregated 40,203,969 kw, an increase of 1,161,864 kw, or 3 per cent, since December 31, 1938. Of the total, 85.7 per cent comprise generating stations owned by private utility companies serving the public, 11.6 per cent publicly owned plants, and 2.7 per cent those operated by railroads and other agencies not distributing to the public. Hydroelectric plants accounted for 11,353,925 kw; steam and internal-combustion plants for 28,850,044 kw. Of the net increase, hydro totaled 287,862 kw, while steam and internal-combustion units increased by 874,002 kw.

Recent major hydroelectric installations reported to the FPC consist of one privately owned 75,000-kw plant in Virginia and a 165,000-kw addition to the generating capacity at Boulder Dam. All other additions in the hydro class were in units of less than 25,000 kw. In steam generation two private companies reported additions in excess of 50,000 kw, and a municipal plant installed an additional 30,000-kw unit.

Famed Naval Dirigible Being Dismantled

The German-built dirigible *Los Angeles*, which covered 140,000 miles for the U. S. Navy before being decommissioned in 1932, is now undergoing structural tests to destruction at the Naval Air Station near Lakehurst, N. J. Having outlasted several of its younger and less fortunate successors, the big airship is fulfilling its final purpose by furnishing data on the structural strength and durability of its component parts.

Constructed in Germany after the close of the World War, the dirigible was flown to the United States by Dr. Hugo Eckener in 1924. After eight years of service it was decommissioned and thenceforth used only for training purposes, never leaving the portable mooring mast to which it was fastened. Meanwhile newer ships of the lighter-than-air type, the *Shenandoah*, the *Akron*, and the *Macon*, were meeting with such a series of destructive misfortunes that the Navy finally abandoned further experiments with large ships of this nature.

Research Survey to Be Made

RAYMOND STEVENS

THE appointment of Raymond Stevens, vice-president of Arthur D. Little, Inc., as director of a nation-wide survey of research in industry which is to be started soon, was announced recently by Dr. Ross G. Harrison, chairman of the National Research Council. In making the announcement, Dr. Harrison stated that while funds for the work had been made available by the National Resources Planning Board, of which Frederic A. Delano is chairman, the survey would be conducted and the report prepared by the National Research Council in accordance with plans approved by an advisory committee of leading scientists, engineers, industrial-research directors, and executives. The report is to be submitted in printed form by the Council next year and would present an objective study of industrial research as a national resource.

Local Sections

Coming Meetings

Baltimore. February 13. Engineers Club at 8:15 p.m. Subject: "Safety, Rescue, and Escape Features of Submarines," by Lieut.-Com. A. M. Morgan, Bureau of Construction and Repairs, Navy Department, Washington, D. C.

Central Pennsylvania. February 16. The Pennsylvania State College at 7:30 p.m. Subject: "The Burning of Fuel and Absorption of Heat in Modern Boiler Units," by E. G. Bailey, vice-president, The Babcock & Wilcox Company, New York, N. Y.

Charlotte. February 9. Dinner meeting to be held at Kannapolis, N. C., at 7:00 p.m. C. A. Cannon, owner of Cannon Mills, one of the largest towel manufacturers in the world, will talk on the subject of Towel Manufacturing. There will also be an inspection trip through the Cannon Towel Mills.

Chicago. February 6. Classroom on 36th floor, Civic Opera Building at 7:30 p.m. Subject: "Social and Economic Aspects of Legislation," by David R. Clarke, Fyffe and Clarke, attorneys. Mr. Clarke is counsel to numerous manufacturing concerns, and is general counsel of the Illinois Manufacturers' Association, and National Metal Trades Association.

February 14. Meeting sponsored by Power and Fuels Division to be held on the 36th floor of the Civic Opera Building. Subject: "Heat Balance Method of Boiler Testing," by E. S. McDonald, efficiency engineer, Kansas City Power & Light Co.

February 20. Junior Group Meeting to be held on the 36th floor of the Civic Opera Building. Subject: "Foreign Engineering Experience," by Theron Wasson, chief geologist, Pure Oil Co.

February 27. Sponsored by Research Division to be held on the second floor of the auditorium, Engineering Building, 205 W. Wacker Drive. Subject: "Research in a Basic Industry," by L. W. Wallace, director, engineering and research division, and John P. Magos, directing engineer, research and development laboratories, of the Crane Company.

Cincinnati. February 15. Cincinnati Club at 8:00 p.m. Subject: "The Relative Importance of Design and Material," by H. W. McQuaid, assistant chief metallurgist, Republic Steel Corporation.

Los Angeles. February 8. Dinner at Mary Louise Tea Room, Barker Brothers Building at 6:30 p.m. Subjects: "What Is the Use of Mathematics From the Standpoint of the Mathematician," by E. T. Bell, professor of mathematics, California Institute of Technology. "What Is the Use of Mathematics From the Standpoint of the Engineer," by Th. von Kármán, professor of aeronautics, director of the Daniel Guggenheim Aeronautics Laboratory, California Institute of Technology.

Philadelphia. February 13. Engineers Club, 1317 Spruce St., Philadelphia, Pa., at 7:30 p.m. Dr. William E. Wickenden, president of the Case School of Applied Science, will speak.

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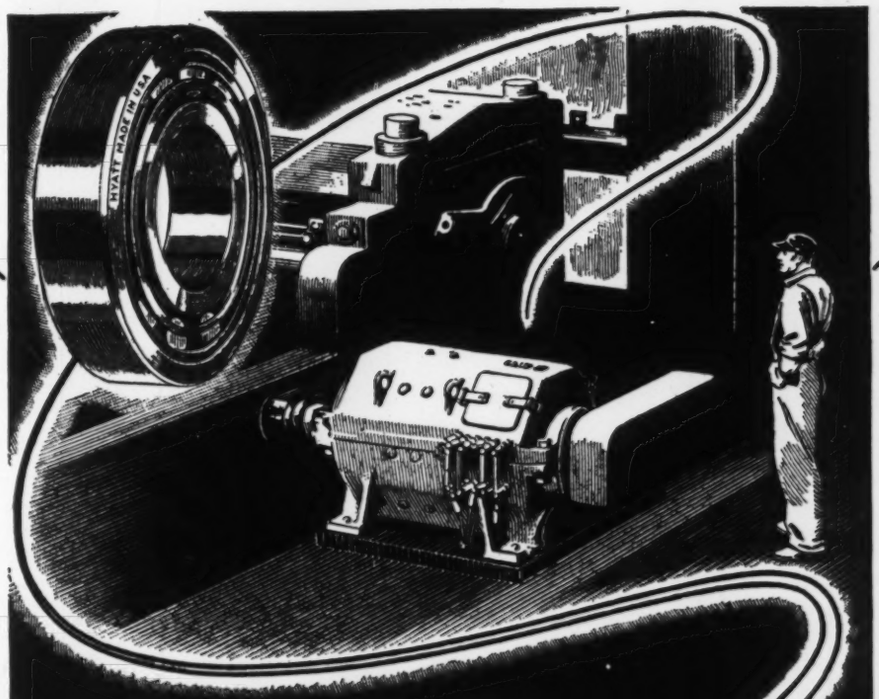


HORSEPOWER and HORSE SENSE

GO WITH HYATTS

TO HOLD THE WHIP HAND

over horsepower . . . to keep it from balking or laying down on the job . . . to reduce its upkeep and prolong its useful life . . . builders of mechanical equipment harness it up with smooth-rolling Hyatt Roller Bearings. They know from experience that horsepower and horse sense go hand in hand with Hyatts to assure the users of their equipment freedom from bearing wear and care. For further details write to Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Chicago, Pittsburgh, Detroit, and San Francisco.

HYATT *Roller* BEARINGS

February 27. Engineers Club, at 7:30 p.m. W. B. Smith will speak on "General Research Phases of Industry." He is connected with the Westinghouse Electric & Manufacturing Co. F. J. Hague of the same company will speak on "Development of Turbine Blades by Research."

San Francisco. February 29, 1940. Engineers' Club, 206 Sansome St., at 6:00 p.m. This will be Ladies' Night and the subject chosen is Color Photography by T. S. Curtis, owner, Curtis Color Camera Factory, Los Angeles, Calif.

Schenectady. February 8. Union College Chapel at 8:00 p.m. The subject has not yet been selected but it has been announced that S. C. Hollister, dean of the College of Engineering, Cornell University, will be the speaker of the evening.

Waterbury. February 21. Hotel Elton Waterbury, Conn., at 8:00 p.m. Subject: "Television," by Donald Pugsley, engineer, radio and television section of the General Electric Co., Bridgeport, Conn.

Worcester. February 6, 1940. Dinner at 6:45 p.m.; meeting at 7:45 p.m. at Sanford Riley Hall, Worcester Polytechnic Institute. Subject: "Welding of Boiler Drums and Pressure Vessels," by H. K. Dean, sales engineer, Babcock & Wilcox Co.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

EXECUTIVE ENGINEER, 50, married, graduate civil engineer. Seventeen years' varied civil-engineering experience; 4 years sales, mechanical engineer, heavy machinery; 6 years general manager complete machinery-manufacturing plant. Available at once. Me-416-383-D-4-San Francisco.

MECHANICAL ENGINEER, 42, Rensselaer graduate. Diversified background as superintendent of manufacture of interchangeable parts, equipment engineer and foundry plant engineer interested in new connection in plant operation and plant improvement. Me-417.

MECHANICAL ENGINEER, 23, single, B.S. Georgia Tech, 1938. Six months' production and 13 months' sales-office experience with pumping-equipment manufacturer. Desires position in testing or production work. Location optional. Me-418.

MECHANICAL ENGINEER, professional license. Eleven years' experience application ventilating, forced, induced-draft fans, economizers, air heaters and pumps. Knows sheet-metal work, duct and pipe design. Can direct construction and installation. Available immediately. Me-419.

MECHANICAL ENGINEER, 22, single, 1939 honor graduate. Desires opportunity for experience leading to responsible engineering position. Present employed in electrical-utility company. Interested in design and production. Me-420.

MECHANICAL ENGINEERING GRADUATE, 30, single. Six years' experience petroleum industry; 3 years sales; 3 years research and design. Now employed. Desires position sales engineering or service work. Industrial eastern seaboard preferred. Me-421.

SALES REPRESENTATIVE OR ASSISTANT SALES MANAGER for material-handling or industrial equipment in New York City and metropolitan area. Could also handle export. Salary or commission basis. Me-422.

MANAGEMENT ENGINEER, 44, married, American. Over 20 years' experience specializing in reduction of costs and simplifying industrial-management control methods in manufacturing plants. Interested in immediate production assignment. Me-423.

MECHANICAL ENGINEER, Brooklyn Polytechnic, professional license. Twenty years chief engineer, process engineer, sales manager for manufacturer industrial instruments serving process industries in controlling temperature, pressure, level, flow, humidity; preferably East. Me-424.

ENGINEER, 45, licensed. Over 20 years' experience in design of steam condensers, heat exchangers, steam-jet evacuators, thermal compressors, and auxiliaries. Inventive ability. Good record. Sales experience. Me-425.

JUNIOR TECHNICAL EXECUTIVE. Graduate mechanical engineer with a thorough knowledge of machinery production and management. Location, secondary. Now employed. Married. Me-426-207-Chicago.

MECHANICAL AND STRUCTURAL ENGINEER, with over 20 years' experience in chemical, copper, and rayon plant design, construction, maintenance, and research in the States and South America seeks responsible position. Me-427.

ADMINISTRATIVE ENGINEER, 30, M.E., M.B.A. Now interested in executive position with manufacturing or research organization offering opportunity to utilize training and experience in automotive design, operation and maintenance, plant management, technical research, corporation finance and taxes, industrial engineering, and public relations. Me-428.

POSITIONS AVAILABLE

DRAFTSMAN-DESIGNER, graduate mechanical engineer experienced in design of machinery and general plant equipment. Location, Middle West. Y-5105C.

MACHINE-TOOL DESIGNER, experienced. Must have initiative. Opportunity. Location, New England. Y-5116.

PRODUCT DESIGNER able to undertake ordnance design. Must have inventive turn of mind, ability to design mechanisms composed of simplest possible parts and ability to cooperate with others. Must also be familiar with medium high volume production in metal industry. Salary, at least $200 a month. Location, New England. Y-5138.

ASSOCIATE EDITOR, about 30. Editorial experience not necessary, but must have ability to write. Experience on college paper would be desirable. Must have experience in mechanical design, preferably machine design. Salary, about $200 a month. Y-5147.

PURCHASING AND CONTACT MAN, 35–45, thoroughly familiar with machine-tool industry. Sales engineer for machine-tool company would be considered. Salary, $7500 a year. Considerable traveling. Headquarters, New York, N. Y. Y-5152.

MECHANICAL OR INDUSTRIAL ENGINEER, young, to estimate jobs and write process cards, routing work through shop on proper machines and in efficiency sequence. Must have good knowledge of machine tools and machine-shop practice. Shop does large jobbing work and includes 8-ft boring mills, 108-in. 30-ft stroker planer, and large lathes, plus usual smaller tools. Salary, $35–$40 a week. Location, Maryland. Y-5158.

RECENT GRADUATE MECHANICAL ENGINEER, preferably with master's degree, who has sound training in engineering fundamentals; good scholastic record. Must have inventive ability, and be able to analyze practical engineering problems. One or two years' experience in engineering work desirable, but not essential. Location, New England. Y-5173.

SALES MANAGER, 35–45. Company will not consider anyone who has not held such a position. Location, East. Y-5177.

RECENT GRADUATE MECHANICAL ENGINEER for training in mechanical shops of large company. Must be in good physical condition, alert, and have potential executive ability. Location, New England. Y-5178.

RECENT GRADUATE MECHANICAL ENGINEER who is interested in metal-working plants. Salary, $125 a month. Location, New York, N. Y. Y-5182.

ACCOUNTANT, mechanical engineer with industrial background, preferably machine shop, to take charge of general books of accounts, do cost accounting, credits, etc. Must be aggressive, have good personality, and be tactful. Salary, $2600 a year. Location, New York, N. Y. Y-5185.

MECHANICAL DRAFTSMAN, 27–35, with good technical education, preferably apprentice graduate with practical experience in small-parts manufacture. Must know how to set limits for interchangeable manufacturing and have good knowledge of machine-shop practice. Location, New York, N. Y. Y-5189.

MECHANICAL ENGINEER with experience in design of heavy machinery. Experience in electrohydraulic steering gears, windlasses, and winches for both naval and merchant-marine service would be desirable, but is not essential. Duties will be layouts, calculations, and general design work on machinery mentioned. Location, Pennsylvania. Y-5190.

SALES ENGINEER, graduate mechanical engineer, 35–40, with gas-engine and gas-compressor experience. This experience is essential. Location, New York, N. Y. Y-5192.

SHOP PRODUCTION ENGINEER who has been in charge of large machine shop in machine-tool trade. Must have wide knowledge of machine-tool operation and latest developments in this field. Location, East Y-5194.

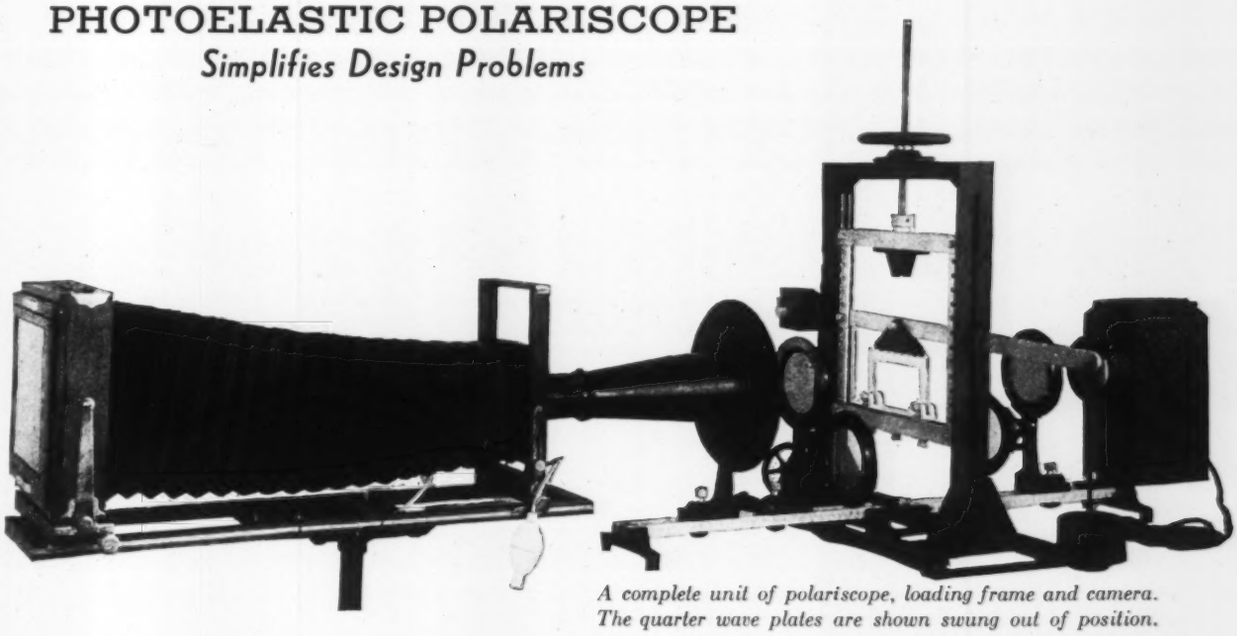
(*A.S.M.E. News continued on page 184*)

[1] All men listed hold some form of A.S.M.E. membership.

Polaroid*—for Stress Determination

with LARGE Aperture PHOTOELASTIC POLARISCOPE

Simplifies Design Problems



A complete unit of polariscope, loading frame and camera. The quarter wave plates are shown swung out of position.

DON'T GUESS AT AREAS OF STRESS CONCENTRATION!—*See them visually.* DON'T GUESS AT AMOUNT OF STRESS!—*Measure it quantitatively.* Axial loads do not always cause uniform stress distribution. The dimensions of a part are not necessarily an indication of its strength. Testing machine parts to the point of break-down and thus approximating stress data can lead to conclusions which are at considerable variance from actual conditions.

Angle Plate under Stress

To the machine designer, photoelastic stress analysis is not only of value in the verification of calculations based on theoretical solutions, but also in the solution of problems where theoretical analysis is not available. Where weight and space must be conserved actual stress distribution is more important than stresses indicated by theoretical analysis.

The Polaroid equipped polariscope makes convenient large aperture investigation in standard clear aperture sizes of $4^1/_4''$, $6^1/_4''$, $8^1/_4''$ and $10''$. The light source may be "white" light or monochromatic at 5461 A°. The new model just announced, has the optical bench made up in two sections greatly facilitating operation with a loading frame. The lens system has been changed over so as to correct for aberration and astigmatism thus giving a sharp picture throughout the field.

The loading frame is of the universal type for tension, compression, and bending, and is available in two sizes.

The camera is on a frame adjustable as to height and is made for plates $5'' \times 7''$, $8'' \times 10''$ or $11'' \times 13''$.

Literature with complete description is available

POLARIZING INSTRUMENT COMPANY

630 FIFTH AVENUE, NEW YORK, N. Y.

* *T. M. Reg. U. S. Pat. Off. by Polaroid Corporation*